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CCL REPORT NO. 267

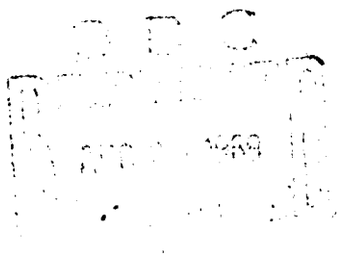
FINAL REPORT

FIELD INVESTIGATION OF THE EXTENDED USE OF MILITARY ANTIFREEZE UNDER DESERT CONDITIONS

BY

CHARLES B. JORDAN

JULY 1969



U. S. ARMY ABERDEEN RESEARCH & DEVELOPMENT CENTER
COATING & CHEMICAL LABORATORY
Aberdeen Proving Ground
Maryland

UNCLASSIFIED

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FIELD INVESTIGATION OF THE EXTENDED USE OF MILITARY ANTIFREEZE UNDER DESERT CONDITIONS

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CHARLES B. JORDAN

JULY 1969

AMCMS CODE NOS. 4930.14.4969 AND 2210.44

U. S. ARMY ABERDEEN RESEARCH & DEVELOPMENT CENTER
COATING AND CHEMICAL LABORATORY
ABERDEEN PROVING GROUND
MARYLAND

ABSTRACT

The object of this test was to evaluate the use of antifreeze O-A-548a, Type I, under high temperature operating conditions and determine the possibility of extending the use of antifreeze beyond the specified one season.

Eight facility vehicles at Yuma Proving Ground were utilized during the test and operated under normal conditions. Four vehicles contained a 50% O-A-548a, Type I, antifreeze solution plus O-I-490a inhibitor. The remaining vehicles contained tap water plus O-I-490a inhibitor.

Results of this test vertify results of previous tests which showed that dilution and proper antifreeze addition is difficult to control. Over extended periods a high volume of antifreeze replacement is necessary due to leaks, mechanical failure, evaporation, and overflow. In the field, uncontrolled, improper additions would lead to extensive and expensive cooling system damage. This test reaffirmed that it is not desirable to extend the use of antifreeze beyond the one season specified in TB 750-651.

Overheating was not experienced in any of the vehicles under the conditions of this test.

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I. INTRODUCTION

Coating & Chemical Laboratory, Aberdeen Proving Ground, Maryland was directed by US Army Tank-Automotive Command, Warren, Michigan to monitor a field test on antifreeze to be conducted on facility vehicles at Yuma Proving Ground, Arizona. The object of the test was to continue the investigation of the possibility of extending the use of antifreeze beyond the one season limit specified in TB-ORD-651, dated April 1964, and to determine the adverse effects, if any, of the use of antifreeze in military vehicles operated under high desert temperatures.

Previous tests conducted at Ft. Dix, New Jersey (1958-1960) were used to establish the persent military policy on the use of antifreeze. Subsequent studies have verified these findings. However, continuing pressure has been exerted to change the policy to permit the use of antifreeze beyond the one season limit. Additional data was desirable in order to recheck the factors affecting the use of antifreeze. This entire test would be under close supervision of test oriented personnel.

In conjunction with this study it was deemed desirable to study the effect of high ambient temperature operation on military antifreeze. Overheating of heavy duty, high energy output vehicles has previously been documented. This test as designed would give specific information on the 1/4-ton, 4X4, utility truck, the 3/4-ton, 4X4, Cargo truck, and the 5-ton, M52A1, tractor truck, operated under facility and test support conditions.

II. DETAILS OF TEST AND TEST RESULTS

Details of test and test results are outlined in the tenth and final letter report, STEYP-TAU, Yuma Proving Ground, 25 April 1969 (Appendix A). Laboratory test results at C&CL were in line with those reported by Yuma Proving Ground.

III. DISCUSSION AND CONCLUSIONS

Examination of the data of the test from July 1966 to January 1967 will show that 5 of 8 vehicles (62-1/2%) had improper coolant additions during this period, even though there were warning cards on the instrument panel and warning tags on the radiator filler neck. In order to reduce the irregular additions, the test director found it necessary to put padlocks on the radiator filler cap. After the installation of the padlocks at least two other improper coolant additions were made (vehicles 5D1149 and 1N74337). It can be seen from this test, that even under the most strict test conditions it was impossible to control the addition of the proper coolant to the vehicle cooling system. This reaffirms past findings that proper control is the biggest factor against extended use.

Retention of antifreeze should be restricted throughout hot summer weather to vehicles with highly efficient cooling systems. Antifreeze

should not be retained in heavy duty, high energy output vehicles due to the low heat capacity of ethylene glycol. Recommendations for retention of antifreeze in hot climates would be based on specific conditions and specific vehicles. No blanket recommendations could be made.

The policy outlined in TB 750-651, 18 November 1968 (revised TB ORD-651) appears to be the most sound policy for the use of antifreeze in military vehicles.

IV REFERENCES

1. Authority: AMCMS Code Nos. 4930.14.4969 dated 22 June 1966 and 2210.44 dated 2 May 1968.

2. Federal Specification O-A-548a, dated 30 December 1958.

3. Federal Specification O-I-490a, dated 26 April 1965.

4. TB 750-651, dated 18 November 1968 (Revised TB-ORD-651, dated April 1964).

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APPENDIX A

TENTH AND FINAL LETTER REPORT ON RESEARCH TEST OF ANTIFREEZE,
SPECIFICATION O-A-548a, TYPE I,
USATECOM PROJECT NO. 7-6-0716-03,
(STEYP-TAU, YUMA PROVING GROUND,
YUMA, ARIZONA, 25 APRIL 1969)

DEPARTMENT OF THE ARMY
Yuma Proving Ground
Yuma, Arizona 85364

25 APR 1969

STEYP-TAU

EDowling/mjo/2699

SUBJECT: Tenth and Final Letter Report on Research Test of Antifreeze, Specification O-A-548A, Type 1, USATECOM Project No. 7-6-0716-03

TO: Commanding General
U.S. Army Tank-Automotive Command
ATTN: AMSTA-RCM.3
Warren, Michigan 48090

Dates of Test: 18 July 1966 through 31 January 1969

1. REFERENCES

a. Letter, USATAC, SMOTA-RTT, subject "Request for Cost Estimate for Test of Antifreeze O-A-548," 28 March 1966.

b. Letter, USATAC, subject "Two-Year Test of Antifreeze, Specification O-A-548," 24 May 1966.

c. Letter, AMXCC-AD, subject "Two-Year Test of Antifreeze, Specification O-A-548," 2 June 1966.

d. STE Form 1028, AMSTE-GE, 31 May 1966.

e. Letter, USATECOM, AMSTE-GE, subject, "USATECOM Project No. 7-6-0716-03, Research of Antifreeze, O-A-548," 3 June 1966.

f. Letter, AMXCC, subject "Two-Year Test of Antifreeze, Specification O-A-548," 15 June 1966.

g. AMC Forms 1095a and 1006A, SMOTA-DCP, subject "Summer Test of Antifreeze O-A-548," 19 January 1967.

h. Technical Bulletin ORD 651, Department of the Army, 10 April 1964.

STEYP-TAU
SUBJECT: Tenth and Final Letter Report on Research Test of Antifreeze, Specification O-A-548A, Type 1, USATECOM Project No. 7-6-0716-03

i. Specification O-A-548A, Type 1, Antifreeze, 12 December 1965.

j. Specification O-I-490A, Inhibitor, Corrosion, Liquid Cooling Systems, 26 April 1959.

k. MIL-C-10597C(ORD), Instructions for Processing Liquid Cooling Systems, 1965.

2. BACKGROUND

The U.S. Army Tank-Automotive Command requested a 2-year test of antifreeze, Federal Specification O-A-548A, at Yuma Proving Ground (YPG), Arizona, to determine the effects of leaving antifreeze in vehicle engine cooling systems during periods of high ambient temperatures. Testing was started on 18 April 1966. Eight facility vehicles were utilized during the test and operated under normal conditions. In February 1967, the test was restarted due to erroneous additions of unprepared coolant solutions to the vehicle cooling systems. The test was completed on 31 January 1969.

This report covers the entire test period from 18 June 1966 through 31 January 1969. Nine interim reports and one supplemental report were submitted during the test period. Measurement of engine operating temperatures proposed in the original test request was deleted by letter from U.S. Army Coating and Chemical Laboratory (CCL), 2 June 1966 (Incl 7) due to funding limitations.

3. OBJECTIVES

a. To determine the effects of leaving antifreeze in vehicle engine cooling systems during desert high ambient temperature conditions.

b. To investigate the possibility of extending the use of antifreeze to 2 years.

c. To verify the provisions in the 1965 revision of Technical Bulletin (TB) ORD 651 pertaining to extending the use of antifreeze to 2 years.

4. DESCRIPTION OF MATERIEL

a. <u>Antifreeze, Ethylene Glycol, Inhibited, Federal Specification O-A-548A, Type 1, FSN 6850-243-1990, Two 55-Gallon Drums</u>

The antifreeze is basically ethylene glycol containing a rust inhibited compound suitable for use in the cooling system of liquid-cooled

internal combustion engines other than aircraft for protection against freezing in ambient temperatures as low as -60°F when diluted to 60 percent by volume with water. The physical characteristics are a blue-green liquid that consists of an extra 100 percent or equal alizarine cyanine green "G" dye added in the ratio of 0.3 gram of dye per gallon of antifreeze compound. Use of Type 1 antifreeze is mandatory for the Department of the Army.

b. Inhibitor, Corrosion, Liquid Cooling System, Federal Specification O-I-490A, FSN 6850-753-4967, Fifty 5-Ounce Cans

This inhibitor is intended to prevent formation of rust deposits in water and/or O-A-548A antifreeze. It is a free-flowing product that consists of a blend of sodium borate, mercaptobenzothiazole and disodium phosphate mixed in the proportions necessary to conform to the following weight requirements:

24.8 to 26.6 percent mercaptobenzothiazole
67.0 to 68.8 percent $Na_2B_4O_7$, anhydrous
14.7 to 16.5 percent Na_2HOP_4, anhydrous

These weight requirements combined are equal to 5 ounces.

Within the specifications of O-I-490A, the composition of corrosion inhibitor by weight (Table 1) is the approved standard by the Department of the Army.

TABLE 1. Composition of Corrosion Inhibitor

Ingredient	Optimum Percent by Weight
Mercaptobenzothiazole (technical grade 92 percent minimum)	15.1
Sodium borate decahydrate $Na_2B_4O_7\ 10H_2O$	75.7
Disodium phosphate anhydrous Na_2HOP_4	9.2

c. Cleaning Compound Kit with Conditioner for Engine Cooling Systems, Military Specification MIL-C-10597C(ORD), FSN 6850-598-7328, 12 Kits

The engine cleaning compound is a kit designed to clean the interiors of cooling systems, to neutralize residual cleaning acids, and

to coat the interiors with a silicate coating. It replaces cleaning compound, FSN 6850-690-5561, which is obsolete. Each complete kit consists of (1) cleaner, Part 1, oxalic acid, (2) cleaner, Part 2, aluminum chloride, (3) sodium silicate conditioner, (4) alkaline conditioner, and (5) instruction sheet.

d. Darbo Freeze Tester

The Darbo Freeze Tester (Incl 1) primarily designed for testing the freezing points of aqueous antifreeze solutions, supplied by the U.S. Army Coating and Chemical Laboratory (CCL), Aberdeen Proving Ground, Maryland, was used throughout the test period.

5. PROCEDURES

The cooling systems of eight facility vehicles were drained and cleaned in accordance with the procedures outlined in TB ORD 651 (Revised, 1965). Each vehicle cooling system was thoroughly inspected and all irregularities found were corrected. All engine coolant hoses were replaced prior to test coolant addition; new 180°F thermostats and new radiator pressure caps were installed.

Radiators were removed from each vehicle and the "flow rate" recorded.

A 50/50 solution of antifreeze, Federal Specification O-A-548a, and tap water with corrosion inhibitor O-I-490A (5 ounces to each 10 quarts of [redacted]) was installed in the engine cooling system of two Scouts, 1/4-Ton, 4x4, IHC, Model 800; one Truck, 3/4-Ton, 4x4, Ford Pickup, Model F250; and one Truck, Tractor, 5-Ton, 6x6, M52A1.

A solution of 100 percent tap water and corrosion inhibitor, O-I-490A (5 ounces to each 10 quarts of water) was installed in the engine cooling systems of two IHC Scouts, one 3/4-ton Ford Pickup, and one M52A1 Truck used as control vehicles.

Each vehicle carried a suitable warning card attached to the instrument panel. Each card indicated that the vehicle was being utilized in support of a 2-year antifreeze test and that specific test data were to be recorded by the vehicle operator, also the procedures to follow when coolant replenishments and maintenance of the engine cooling system were required.

Warning tags were attached to the radiator filler neck indicating the type of coolant solution installed and the date of installation.

A 1-gallon sample of tap water taken from well "T" was shipped to CCL for analysis.

The antifreeze sample required by CCL at the start of the test (Supplement 1 of the Revised Test Program, USATAC, 13 May 1966) was taken from the test antifreeze by CCL prior to shipment to YPG.

During February 1967, the cooling system of the four facility vehicles in which the antifreeze had been installed and one of the control vehicles was drained and recleaned as a result of erroneous coolant additions. The systems were refilled with test coolant. Padlocks were installed on all vehicle radiator pressure caps for closer control of coolant replenishments. This procedure was approved by CCL personnel.

Observations of the cooling systems of the vehicles containing test antifreeze and of the control vehicles were made during vehicle operation on various types of terrain during normal facility and test support use. Nine quarterly maintenance inspections were performed to prevent or correct irregularities. During these inspections, samples of the test coolant were removed from each vehicle and forwarded to CCL for analysis to determine pH value, reserve alkalinity, boiling point, flash point and freezing point.

Duplicate samples of coolant were removed and analyzed at Yuma Proving Ground. Chemical analyses were performed at Yuma Proving Ground using the following documents and instruments:

a. Federal Specification O-A-548A, Type 1, Antifreeze, Ethylene Glycol, Inhibited, dated 30 December 1968.

b. Federal Specification O-I-490A, Inhibitor, Corrosion, Liquid Cooling System, dated 27 November 1967.

c. TB ORD 651, Department of the Army, Revised 1965.

d. Military Specification MIL-C-10597C(ORD), 1965.

e. Darbo Freeze Tester. This instrument was used for testing freezing points of aqueous antifreeze solutions. The tester is a small hand-held plastic device fitted with a thermometer, brass sample cup (2.0 milliliter capacity), and a port passage for introducing compressed CO_2. The tester was used as follows:

(1) The thermometer was held loosely in the cup so that in the freezing process, it can serve as a stirrer as well as an indicator of temperature. The thermometer scale ranges from +70°F to -70°F with graduations of 2.0 degrees.

(2) Freezing of the antifreeze solution was accomplished by introducing compressed CO_2 into the recesses surrounding the brass cup. The unit was so designed that CO_2 may be used from a portable CO_2 fire extinguisher or from a small CO_2 seltzer charge.

(3) To measure the freezing point of the solution, the brass cup was filled to the lip with antifreeze, and CO_2 carefully introduced around the cup. The expansion of the CO_2 results in rapid lowering of the temperature of the sample. As the temperature is lowered, the antifreeze sample was gently stirred with the thermometer. At the point of the first crystallization of ice in the antifreeze solution, the thermometer was read to the nearest 1.0 degree. At this point, the CO_2 was withdrawn and crystallization continued to increase. Stirring of the slushy liquid was continued and melting of the ice crystals soon began.

(4) When the last visible ice crystals were noted in the antifreeze, the temperature was again read; this temperature was found to be the same as that where crystallization of ice started.

f. Refractometer, VU-Chek, Antifreeze and Battery Tester, Type AF-1400. This instrument was used for testing antifreeze protection and is a small hand-held device used by placing the plastic cover over the measuring window, then applying a few drops of antifreeze solution from the clear plastic pump onto the surface of the measuring window. By pointing the instrument towards any light source and sighting through the eyepiece, the results could be read on the underside of the measuring window where the "shadowed" line crosses the scale.

6. SUMMARY OF RESULTS

No difficulty was encountered during processing of the vehicle engine cooling systems or installation of the coolant solutions.

Installation data are shown in Table 2.

TABLE 2. Installation Data, 18 July 1966

Model	USA Reg No.	Odometer Reading (in.)	Radiator Flow Rate (gpm)	Cooling Capacity (qt)	Coolant Solution*	Condition of Cooling System
IHC800	1R5337	248	26	13.5	A	Good. No rust deposits or system defects.
IHC800	1R5339	559	27	13.5	B	↑
IHC800	1R5347	984	25.5	13.5	B	↓
IHC800	1R5352	185	26	13.5	A	Good. No rust deposits or system defects.
F250	1N7437	11287	30	17.0	A	Good. Slight rust deposits at radiator filler neck, before cleaning.
F250	1N7438	13761	30	17.0	B	Good. Slight rust deposits at radiator filler neck, before cleaning.
M52A1	5D1140	12610	55	44.0	B	Poor. Heavy rust solution drained. No system defects. Fair condition after cleaning.
M52A1	5D1149	4064	55	44.0	A	Poor. Heavy rust solution drained. No system defects. Fair condition after cleaning.

*A - 50/50 Solution of antifreeze, O-A-548A, and tap water
B - 100 Percent tap water and corrosion inhibitor, O-I-490A

At the conclusion of testing, the cooling systems of the four vehicles containing test antifreeze were inspected and determined to be in satisfactory condition; the test antifreeze had no adverse effects on the cooling systems. The cooling systems of the four control vehicles without antifreeze were inspected and determined to be in satisfactory condition. Final inspection data are shown in Table 3.

TABLE 3. Final Inspection Data, 3 February 1969

Model	USA Reg No.	Odometer Reading (mi)	Total Test Miles	Radiator Flow Rate (gpm)	Condition of Cooling System
IHC800	1R5337	14625	12016	26	Good. No rust deposits or system defects.
IHC800	1R5339	15976	15416	24	↕
IHC800	1R5347	18929	17945	25	↕
IHC800	1R5352	12830	8359	26	Good. No rust deposits are system defects.
F250	1N7437	34560	23270	30	Fair. Slight rust deposits at filler neck. Slight coolant contamination. No leaks. Radiator hose, pressure cap and thermostat replaced.
F250	1N7438	30584	17186	30	New radiator installed 30 June 1968. System in fair condition. No defects or rust pitting. Coolant slightly contaminated.
M52A1	5D1140	33026	22516	55	Fair. Solution heavily contaminated. No coolant leaks. Rust deposits at filler neck.
M52A1	5D1149	28330	24266	55	Fair. Solution heavily contaminated. No coolant leaks.

The Darbo Freeze Tester and VU-Chek antifreeze and battery tester produced results comparable to the ASTM procedures.

Results of the chemical analysis of the water used in preparing the test coolant solutions are contained in Inclosure 3.

A summary of vehicle operations and test results is contained in Inclosure 4.

Results of the chemical analysis performed by Yuma Proving Ground on the test coolant samples are contained in Inclosure 5.

Meteorological data for July 1966 through January 1969 are contained in Inclosure 6.

A copy of the test program and changes is included in Inclosure 7.

7. DISCUSSION

Facility vehicles are generally dispatched to offices, sections and units for personnel transportation requirements. Mission support vehicles are used in direct support of tests and are generally assigned one to two drivers during one 8-hour shift.

Four of the IHC Scouts were facility vehicles. The two Ford Pickups and the two M52A1 5-Ton Trucks were mission support vehicles.

Between July 1966 and January 1967, the method of controlling additions to the cooling system proved inadequate due to vehicle operator negligence in performing the required before, during, and after preventive services and failure to adhere to the instructions provided with the vehicle (tag on radiator cap and placard on instrument panel). As a result, the coolant solutions of the four vehicles containing test antifreeze and of one control vehicle were contaminated. The test was restarted with new prepared coolant solutions, and a more stringent method of controlling coolant additions throughout the remainder of the test.

Since small hand tools normally a part of on-vehicle equipment were not carried on the facility vehicles, minor coolant seeps were, on occasion, allowed to continue until adjustment and/or replacement of hose clamps could be made.

Controlling the ratio of a specially prepared coolant solution installed in a vehicle cooling system under tactical conditions would be difficult and is not considered feasible.

8. CONCLUSIONS

Not applicable

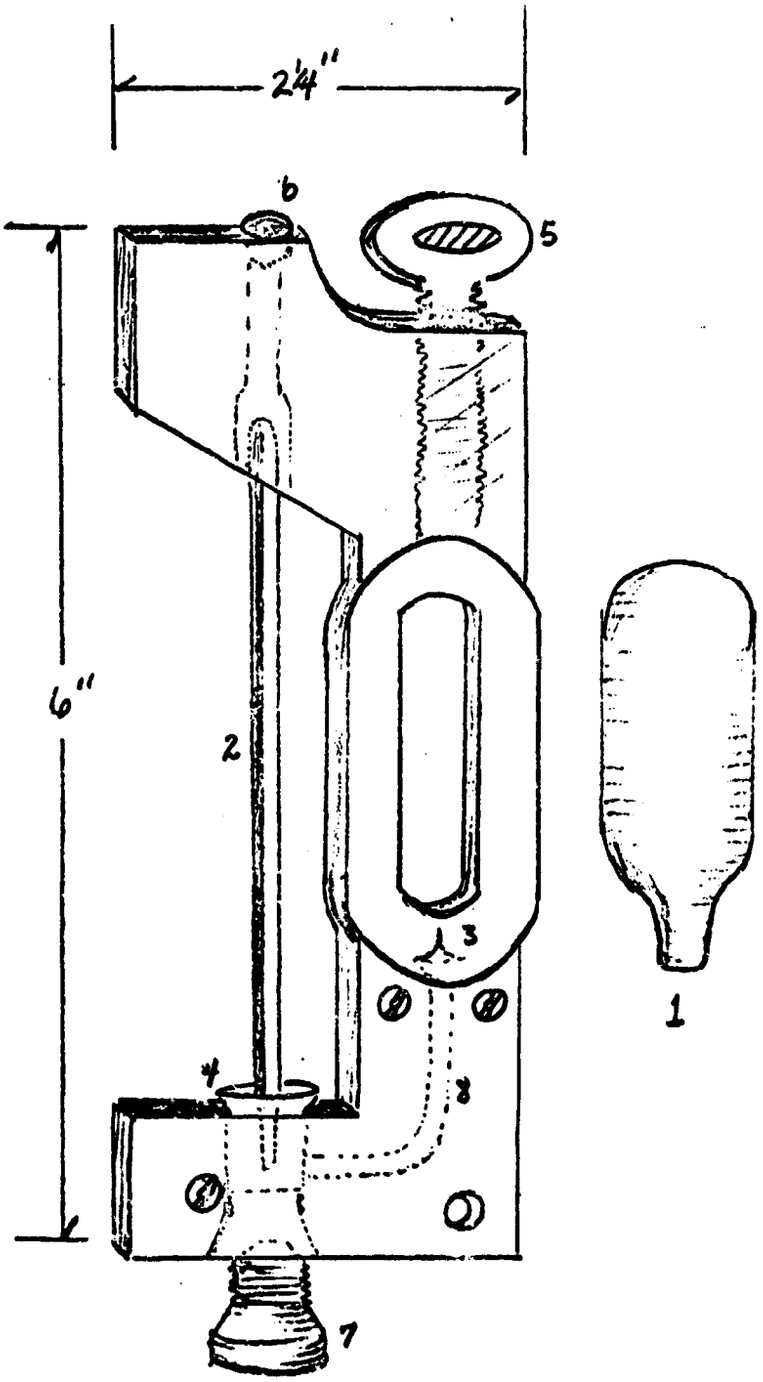
9. RECOMMENDATIONS

Not applicable

FOR THE COMMANDER:

Ramon Hick
for J. H. WATTS
COL, CmlC
Director, Test and Evaluation

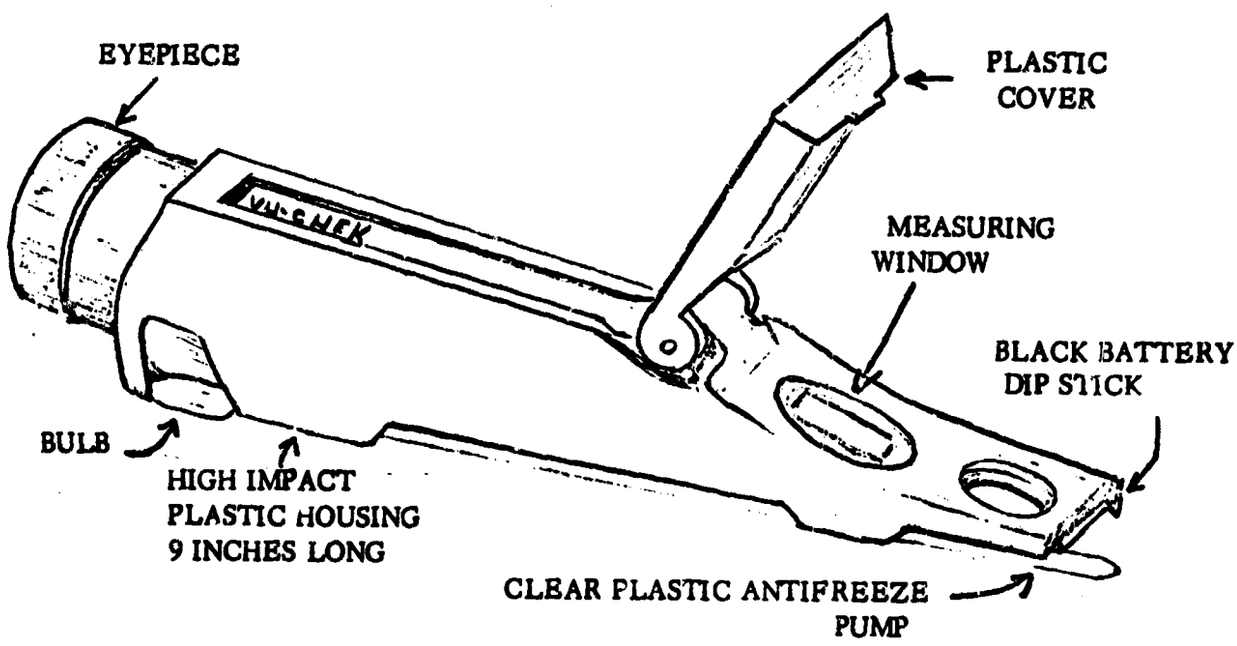
8 Incl
1. Sketch Darbo Tester
2. Sketch VU-Chek
3. Water Analysis Summary
4. Summary of Vehicle Operations
5. Chemical Analyses of Coolant
6. Meteorological Data
7. Test Program Request and Changes
8. Distribution List



DARBO FREEZE TESTER, PLASTIC

1. CO_2 cylinder
2. Thermometer stirrer
3. Cylinder perforator
4. Sample vat (2.0 ml cat)
5. Cylinder clamp screw
6. Rubber plug
7. Optional CO_2 fitting
8. CO_2 port

Incl 1



VU-Check Antifreeze and Battery Tester

Incl 2

WATER ANALYSIS SUMMARY
MARCH 1966

Characteristics	Parts per Million	Characteristics	Parts per Million
Silica ($SiO2$)	29.0	Silver (Ag)	0
Iron (Fe)	None	Barium (Ba)	0.002
Manganese (Mn)	1.00	Cadmium (Cd)	0
Calcium (Ca)	44	Cyanide (Cn)	0
Magnesium (Mg)	6	Chromium (Cr) hexavalent	0.02
Sodium (Na)	204	Nitrate (NO_3)	0.95
Potassium (K)	29	Dissolved solids residue on evap (180°F)	890
Bicarbonate (HCO_3)	129		
Carbonate (CO_3)	0		
Sulfate (SO_4)	138		
Chloride (CL)	250	Hardness as $CaCO_3$	63
Fluoride (F)	7.25	Selenium (Se)	-
Boron (B)	1.30	Noncarbonate hardness ($CaCO_3$)	0
Arsenic (As)	0.0215		
Copper (Cu)	.03	Alkalinity as $CaCO_3$	90
Zinc (Zn)	0.04	Specific conductance (micromhos 25°C)	1380
Lead (Pb)	0.0475		
		pH	7.70
		Color	1

NOTE: Analysis on water from Well "T" at Yuma Proving Ground. Water chlorinated with HTH (active ingredient sodium hypochlorite). Depth: 400 feet (est)

Incl 3

SUMMARY OF VEHICLE OPERATIONS

Date	Odom (mi)	Test Miles	Coolant Added (oz)	Radiator Flow Rate (gpm)	Comments
Truck, Utility, 1/4-Ton, 4x4, IHC Scout, Model 800, USA Reg No. 1R5337 Coolant solution installed: 50/50 Antifreeze, O-A-548A, and tap water					
18 Jul 66	249	0	480	26	Start test. Test coolant installed, 13.5 quarts.
19 Oct 66	1711	1462	32	-	Coolant low. No leaks.
28 Oct 66	1747	1498	8	-	First quarterly inspection. Removed 8-ounce sample. No leaks.
17 Jan 67	2488	2239	0	-	Second quarterly inspection. No leaks.
2 Feb 67	2613	2364	480	-	System drained. Test restarted. Solution 49.9 antifreeze; 50.1 tap water. Freeze point, -33°F.
23 Feb 67	2875	262	0	-	Installed padlock on radiator pressure cap.
17 May 67	5288	2675	16	-	Coolant low. No leaks.
22 Jun 67	5640	3027	8	-	Third quarterly inspection. Removed 8-ounce sample. No leaks.
23 Oct 67	7381	4768	8	-	Fourth quarterly inspection. Removed 8-ounce sample. No leaks.
7 Jan 68	9004	6391	48	-	Fifth quarterly inspection. Coolant low. Removed 8-ounce sample. Replaced 48 ounces.
15 Apr 68	10371	7758	32	-	Sixth quarterly inspection. Removed two 8-ounce samples. Coolant low. Replaced 32 ounces.
1 Jul 68	11453	8840	16	-	Coolant level low. Replaced 16 ounces.
24 Jul 68	11770	9157	8	-	Seventh quarterly inspection. Removed 8-ounce sample. No leaks.
26 Oct 68	13181	10568	24	-	Eighth quarterly inspection. Tightened hose clamps. Removed 8-ounce sample. Replaced 24 ounces.
3 Feb 69	14625	12016	0	26	Ninth quarterly and final inspection. No cooling system defects. One-gallon sample removed. System drained. Radiator flow rate recorded. Test ended.

Total miles (2 Feb 67 - 3 Feb 69): 12016

Total coolant added (2 Feb 67 - 3 Feb 69): 160 ounces

SUMMARY OF VEHICLE OPERATIONS (Continued)

Date	Odom (mi)	Test Miles	Coolant Added (oz)	Radiator Flow Rate (gpm)	Comments
Truck, Utility, 1/4-Ton, 4x4, IHC Scout, Model 800, USA Reg No. 1R5339 Coolant solution installed: Corrosion inhibitor 0-1-490 and tap water					
18 Jul 66	559	0	480	27	Start test. Test coolant installed, 13.5 quarts.
19 Sep 66	1604	1046	32	-	Coolant level low. No leaks.
27 Oct 66	2160	1602	8	-	First quarterly inspection. Removed 8-ounce sample. No leaks.
24 Jan 67	3935	3377	43	-	Second quarterly inspection. Coolant level low. Installed padlock on radiator pressure cap. Cooling system was not drained. Removed 8-ounce sample.
19 Jun 67	6260	5702	8	-	Third quarterly inspection. No leaks. Removed 8-ounce sample.
23 Oct 67	8509	7951	136	-	Fourth quarterly inspection. No leaks noted. Removed 8-ounce sample. Replaced 136 ounces.
8 Jan 68	9866	9309	80	-	Fifth quarterly inspection. No leaks noted. Replaced radiator pressure cap. Removed 8-ounce sample. Replaced 32 ounces; 48 ounces were replaced on 7 January 1968 due to a faulty radiator pressure cap.
15 Apr 68	11914	11354	16	-	Sixth quarterly inspection. No leaks noted. Removed 8-ounce sample. Replaced 16 ounces.
24 Jul 68	13436	12876	16	-	Seventh quarterly inspection. No leaks noted. Removed 8-ounce sample. Replaced 16 ounces.
22 Aug 68	13963	13403	16	-	Visual inspection. Coolant level low. Replaced 16 ounces. No leaks noted.
26 Oct 68	14797	14237	16	-	Eighth quarterly inspection. No leaks noted. Coolant level low. Removed 8-ounce sample. Replaced 16 ounces.
3 Feb 69	15976	15416	0	24	Ninth quarterly and final inspection. No leaks noted. System satisfactory. Removed 1-gallon coolant sample and drained system. Test ended.

Total miles (18 Jul 66 - 3 Feb 69): 15416
Total coolant added (18 Jul 66 - 3 Feb 69): 371 ounces

SUMMARY OF VEHICLE OPERATIONS (Continued)

Date	Odom (mi)	Test Miles	Coolant Added (oz)	Radiator Flow Rate (gpm)	Comments
Truck, Utility, 1/4-Ton, IHC Scout, Model 800, USA Reg No. 1R5347 Coolant solution installed: Corrosion inhibitor O-1-490 and tap water					
18 Jul 66	984	0	480	25.5	Start test. Test coolant installed, 13.5 quarts.
26 Oct 66	2989	2005	40	-	First quarterly inspection. Replaced radiator upper hose clamp to stop coolant seep. Removed 8-ounce sample. Replaced 40 ounces.
24 Jan 67	3935	3377	43	-	Second quarterly inspection. No leaks noted. Cooling system was not drained. Installed padlock on radiator pressure cap. Removed 8-ounce sample. Replaced 43 ounces.
19 Jun 67	7881	6897	8	-	Third quarterly inspection. No leaks noted. Removed 8-ounce sample.
17 Jul 67	8421	7437	32	-	Visual inspection. No leaks noted. Coolant level low. Replaced 32 ounces.
24 Aug 67	9358	8374	16	-	Visual inspection. No leaks noted. Coolant level low. Replaced 16 ounces.
23 Oct 67	10665	9681	40	-	Fourth quarterly inspection. No leaks noted. Removed 8-ounce sample. Replaced 40 ounces.
20 Nov 67	11540	10556	8	-	Visual inspection. No leaks noted. Replaced 8 ounces. Coolant low.
15 Dec 67	11815	10831	32	-	Visual inspection. Corrosion around radiator filler neck indicates boiling. No leaks noted. Replaced 32 ounces.
5 Jan 68	12096	11112	160	-	Fifth quarterly inspection. Removed radiator and repaired radiator lower tank. 96 ounces of test coolant lost during operation. 64 ounces lost during maintenance. Removed 8-ounce sample. Replaced pressure cap. Replaced radiator lower hose clamp. Replaced 160 ounces.

SUMMARY OF VEHICLE OPERATIONS (Continued)

Date	Odom (mi)	Test Miles	Coolant Added (oz)	Radiator Flow Rate (gpm)	Comments
15 Apr 68	13747	12763	32	-	Sixth quarterly inspection. No leaks noted. Coolant level low. Removed 16-ounce sample. Replaced 32 ounces.
23 Jul 68	15254	14270	32	-	Seventh quarterly inspection. No leaks noted. Coolant level low. Replaced 16 ounces on 12 July. Replaced water pump seal. Replaced 16 ounces. No leaks noted.
23 Sep 68	16500	15516	32	-	During 9, 10 and 11 September 1968, 32 ounces of test coolant were added. Vehicle operating temperature was above +190°F. No leaks noted.
26 Oct 68	17110	16126	32	-	Eighth quarterly inspection. No leaks noted. Coolant level low. Removed 8-ounce sample. Replaced 32 ounces.
3 Feb 69	18929	17945	0	25	Ninth quarterly and final inspection. No leaks noted. Removed 1-gallon coolant sample. Replaced radiator cap and thermostat. Test ended.

Total miles (18 Jul 66 - 3 Feb 69): 17945
Total coolant added (18 Jul 66 - 3 Feb 69): 507 ounces

SUMMARY OF VEHICLE OPERATIONS (Continued)

Date	Odom (mi)	Test Miles	Coolant Added (oz)	Radiator Flow Rate (gpm)	Comments
Truck, Utility, 1/4-Ton, 4x4, IHC Scout, Model 800, USA Reg No. 1R5352 Coolant solution installed: 50/50 Antifreeze O-A-548A and tap water					
18 Jul 66	185	0	480	26	Start test. Test coolant installed, 13.5 quarts.
19 Aug 66	571	386	32	-	Coolant level low. Replaced 32 ounces. No leaks noted.
26 Oct 66	2540	2355	40	-	First quarterly inspection. Coolant level low. Removed 8-ounce sample. Replaced 40 ounces. No leaks noted.
28 Nov 66	3237	3052	16	-	Coolant level below normal. Replaced 16 ounces. No leaks noted.
28 Dec 66	4059	3874	16	-	Tightened radiator lower hose clamp. Replaced 16 ounces. No leaks noted.
27 Jan 67	4417	4232	48	-	Replaced radiator lower hose clamp. Added 48 ounces of coolant.
1 Feb 67	4471	4286	480	-	Second quarterly inspection. Cooling system drained, flushed and refilled with 49.9 percent antifreeze, O-A-548A, and 50.1 percent tap water. Test restarted. Installed padlock on radiator pressure cap.
19 Jun 67	6522	2051	8	-	Third quarterly inspection. No leaks noted. Removed 8-ounce sample.
23 Oct 67	7693	3222	8	-	Fourth quarterly inspection. No leaks noted. Removed 8-ounce sample.
7 Jan 68	7979	3508	24	-	Fifth quarterly inspection. No leaks noted. Coolant level low. Removed 8-ounce sample. Replaced 24 ounces.

SUMMARY OF VEHICLE OPERATIONS (Continued)

Date	Odom (mi)	Test Miles	Coolant Added (oz)	Radiator Flow Rate (gpm)	Comments
15 Apr 68	9565	5094	16	-	Sixth quarterly inspection. Slight corrosion deposits. No leaks noted. Removed two 8-ounce samples.
23 Jul 68	10214	5743	8	-	Seventh quarterly inspection. No leaks noted. Removed 8-ounce sample.
22 Aug 68	10403	5932	16	-	Visual inspection. No leaks noted. Coolant level low. Replaced 16 ounces.
26 Oct 68	11267	6796	16	-	Eighth quarterly inspection. No leaks noted. Coolant level low. Removed 8-ounce sample. Replaced 16 ounces.
3 Feb 69	12830	8359	0	26	Ninth quarterly and final inspection. Slight seepage at radiator upper hose due to loose hose clamp. Removed 1-gallon coolant sample and drained cooling system. Test ended.

Total miles (1 Feb 67 - 3 Feb 69): 8359
Total coolant added (1 Feb 67 - 3 Feb 69): 96 ounces

SUMMARY OF VEHICLE OPERATIONS (Continued)

Date	Odom (mi)	Test Miles	Coolant Added (oz)	Radiator Flow Rate (gpm)	Comments
Truck, Cargo, 3/4-Ton, 4x4, Ford Pickup, Model F250, USA Reg No. 1N7437 Coolant solution installed: 50/50 Antifreeze O-A-548A and tap water					
18 Jul 66	11287	0	544	30	Start test. Test coolant installed, 17 quarts.
2 Aug 66	11482	195	40	-	Visual inspection. Replaced radiator upper hose clamp. Replaced 40 ounces.
14 Oct 66	13211	1924	24	-	Visual inspection. Replaced radiator lower hose clamp. Replaced 24 ounces.
19 Oct 66	15406	2195	8	-	First quarterly inspection. No leaks noted. Removed 8-ounce sample.
26 Jan 67	15607	4320	0	-	Second quarterly inspection. Satisfactory.
2 Feb 67	15900	4613	544	-	Test restarted. Cooling system drained and flushed. Refilled system with new solution of 49.9 percent antifreeze and 50.1 percent tap water. Padlock installed on radiator pressure cap.
19 Jun 67	20814	4914	8	-	Third quarterly inspection. No leaks noted. Removed 8-ounce sample.
20 Sep 67	22615	6715	32	-	Coolant level low. No leaks noted. Replaced 32 ounces.
23 Oct 67	23494	7594	8	-	Fourth quarterly inspection. No leaks noted. Removed 8-ounce sample.
8 Jan 68	25805	9900	40	-	Fifth quarterly inspection. Replaced heater coolant inlet flow valve. Removed 8-ounce sample. Replaced 40 ounces.
6 Feb 68	26848	10943	32	-	Replaced faulty radiator lower hose clamp. Replaced 32 ounces. No additional leaks noted.

SUMMARY OF VEHICLE OPERATIONS (Continued)

Date	Odom (mi)	Test Miles	Coolant Added (oz)	Radiator Flow Rate (gpm)	Comments
8 Feb 68	27015	11110	96	-	Replaced failed radiator upper hose and radiator pressure cap. Replaced 96 ounces.
15 Apr 68	29091	13186	16	-	Sixth quarterly inspection. No leaks noted. Removed two 8-ounce samples.
23 Jul 68	30189	14286	8	-	Seventh quarterly inspection. No leaks noted. Removed 8-ounce sample.
26 Oct 68	31854	15951	8	-	Eighth quarterly inspection. No leaks noted. Removed 8-ounce sample.
3 Feb 69	34560	18657	0	30	Ninth quarterly and final inspection. Coolant seep found at radiator lower hose. Pressure cap recorded at 4 psi. Thermostat dropped from 180°F to 140°F. Removed 1-gallon coolant sample and drained cooling system. The hose, radiator pressure cap and thermostat were replaced. Test ended.

Total miles (2 Feb 67 - 3 Feb 69): 18657
Total coolant added (2 Feb 67 - 3 Feb 69): 248 ounces

SUMMARY OF VEHICLE OPERATIONS (Continued)

Date	Odom (mi)	Test Miles	Coolant Added (oz)	Radiator Flow Rate (gpm)	Comments
Truck, Cargo, 3/4-Ton, 4x4, Ford Pickup, Model F250, USA Reg No. 1N7438 Coolant solution installed: Corrosion inhibitor 0-1-490 and tap water					
18 Jul 66	13761	0	544	30	Start test. Test coolant installed, 17 quarts.
21 Oct 66	15619	1858	16	-	First quarterly inspection. Replaced radiator lower hose clamp. Coolant level low. Removed 8-ounce sample. Replaced 16 ounces.
31 Jan 67	18162	4401	0	-	Second quarterly inspection. No leaks noted. Removed 8-ounce sample. No coolant added.
3 May 67	20737	6976	128	-	Visual operational inspection. No leaks noted. Coolant boiling and overflow indicated. Suspect clogging. Replaced 128 ounces. Padlock was installed on radiator pressure cap on 3 February 1967.
19 Jun 67	21941	8542	8	-	Third quarterly inspection. No leaks noted. Removed 8-ounce sample.
30 Jun 67	22075	8677	544	17	Operational inspection revealed a heavy loss of test coolant through the overflow tube due to boiling. An 8-ounce sample was removed and the system drained (approx. 5 qt). The radiator was removed, disassembled and shipped to CCL for further analysis. A new radiator and new test coolant were installed.
23 Oct 67	23055	9657	8	30	Fourth quarterly inspection. No leaks noted. Removed 8-ounce sample.

SUMMARY OF VEHICLE OPERATIONS (Continued)

Date	Odom (mi)	Test Miles	Coolant Added (oz)	Radiator Flow Rate (gpm)	Comments
20 Nov 67	23705	10307	64	-	Visual inspection. No leaks noted. On 30 October 1967, 64 ounces of test coolant were replaced due to coolant overflow and faulty radiator lower hose clamp. Clamp was replaced.
5 Jan 68	24786	11388	8	-	Fifth quarterly inspection. No leaks noted. Removed 8-ounce sample.
15 Apr 68	25314	11916	16	-	Sixth quarterly inspection. No leaks noted. Removed two 8-ounce samples. Replaced 16 ounces.
24 May 68	25995	12597	112	-	Visual inspection during test support. Coolant found seeping from radiator lower hose. Replaced hose clamp. Replaced 112 ounces of test coolant. No additional leaks noted.
23 Jul 68	27396	13998	8	-	Seventh quarterly inspection. No leaks noted. Removed 8-ounce sample.
22 Aug 68	28167	14769	48	-	Visual inspection revealed coolant level below radiator core. No leaks were found. Replaced 48 ounces of test coolant.
31 Oct 68	30078	16680	264	-	Eighth quarterly inspection. No leaks noted. Removed 8-ounce sample. On 14 October 1968, the radiator upper hose failed. The failed hose was replaced and 256 ounces of test coolant. The failed hose was shipped to CCL for further analysis.
4 Feb 69	30584	17186	0	30	Ninth quarterly and final inspection. No leaks noted. No system defects. 1-Gallon coolant sample removed. Test ended.

Total miles (18 Jul 66 - 3 Feb 69): 17186
Total coolant added (18 Jul 66 - 3 Feb 69): 1766 ounces

SUMMARY OF VEHICLE OPERATIONS (Continued)

Date	Odom (mi)	Test Miles	Coolant Added (oz)	Radiator Flow Rate (gpm)	Comments
Truck, Tractor, 5-Ton, 6x6, M52A1, USA Reg No. 501140 Coolant solution installed: Corrosion inhibitor 0-1-490 and tap water					
18 Jul 66	12610	0	1408	55	Start test. Test coolant installed, 44 quarts.
22 Nov 66	16984	4374	64	-	First quarterly inspection. No leaks noted. Indications of overheating. Solution was a rust red color. Rust deposits in radiator filler neck. Coolant level low. Removed 8-ounce sample. Replaced 64 ounces.
23 Jan 67	18144	5534	8	-	Second quarterly inspection. No leaks noted. Removed 8-ounce sample.
23 Feb 67	18727	6118	1408	-	Maintenance inspection. Removed 8-ounce sample. No leaks noted. System drained and flushed. New solution of test coolant installed. Installed padlock on radiator pressure cap. Freeze recorded at +32°F. Test restarted.
9 May 67	19497	770	1408	-	Front motor mount failed causing radiator hose to rupture and a loss of test coolant. Motor mount was replaced; remainder of test coolant solution erroneously drained. The cooling system was refilled with new test coolant solution and test continued. Radiator pressure cap replaced on 27 May 1967.
19 Jun 67	22269	2772	8	-	Third quarterly inspection. No leaks noted. Removed 8-ounce sample.
31 Aug 67	23327	3830	128	-	Visual inspection during operation. Radiator lower hose loose. Hose clamp replaced. Replaced 128 ounces.

SUMMARY OF VEHICLE OPERATIONS (Continued)

Date	Odom (mi)	Test Miles	Coolant Added (oz)	Radiator Flow Rate (gpm)	Comments
23 Oct 67	27322	7825	8	-	Fourth quarterly inspection. No leaks noted. Removed 8-ounce sample.
17 Nov 67	27460	7963	64	-	Repaired radiator top tank at center brace. Replaced 64 ounces test coolant.
10 Jan 68	27469	7972	8	-	Fifth quarterly inspection. No leaks noted. Removed 8-ounce sample. Vehicle deadlined for fifth wheel parts.
20 Feb 68	28016	8519	32	-	Maintenance inspection. Test coolant drained. Radiator removed and top tank repaired. Radiator reinstalled. The drained test coolant was also reinstalled. Replaced 32 ounces of test coolant. No leaks noted after maintenance.
26 Feb 68	28852	9455	128	-	Repaired radiator top tank and lower tank. Replaced 128 ounces test coolant.
13 Mar 68	30423	11026	32	-	Visual inspection. No leaks noted. Coolant level below radiator core. Replaced 32 ounces test coolant.
15 Apr 68	30781	11384	16	-	Sixth quarterly inspection. No leaks noted. Removed two 8-ounce samples.
12 May 68	30896	11499	256	-	Visual inspection. The radiator upper hose failed while vehicle was towing a 20,000-pound payload. A new hose was installed in the field. Repaired radiator upper tank center bracket. Replaced 256 ounces of test coolant. Indications of boiling and rust.
26 Jul 68	31779	12382	48	-	Seventh quarterly inspection. No leaks noted except through overflow tube. Coolant level below radiator core. Replaced 48 ounces of test coolant (including 8-ounce sample removed).

SUMMARY OF VEHICLE OPERATIONS (Continued)

Date	Odom (mi)	Test Miles	Coolant Added (oz)	Radiator Flow Rate (gpm)	Comments
20 Aug 68	32116	12719	32	-	Visual inspection. No leaks noted. On 14 August 1968, 32 ounces of test coolant was replaced. No leaks or defects were noted. Vehicle operating with 10,000-pound payload on level cross-country.
31 Oct 68	32951	13554	96	-	Eight quarterly inspection. Tightened radiator hose clamp. Removed 8-ounce sample. Coolant level low. Replaced 96 ounces.
4 Feb 69	33026	13629	0	55	Ninth quarterly and final inspection. No visible leaks or defects noted. Removed 1-gallon sample. Removed radiator and checked flow rate. Test ended.

Total miles (23 Feb 67 - 3 Feb 69): 13629
Total coolant added (23 Feb 67 - 3 Feb 69): 2264 ounces

SUMMARY OF VEHICLE OPERATIONS (Continued)

Date	Odom (mi)	Test Miles	Coolant Added (oz)	Radiator Flow Rate (gpm)	Comments
Truck, Tractor, 5-Ton, 6x6, M52A1, USA Reg No. 5D1149 Coolant solution installed: 50/50 antifreeze O-A-548A and tap water.					
18 Jul 66	4064	0	1408	55	Start test. Test coolant installed, 44 quarts.
26 Oct 66	5294	1230	16	-	First quarterly inspection. Vehicle air compressor removed for maintenance resulting in loss of 8 ounces of test coolant. Radiator had to be removed during above maintenance. Removed 8-ounce test sample. Replaced 16 ounces of test coolant.
26 Jan 67	10035	5971	0	-	Second quarterly inspection. No leaks or defects noted. Sample was not removed.
3 Feb 67	10077	6013	1408	-	Test restarted. Cooling system drained and flushed; inspected by CCL. No leaks noted. A new solution was installed (49.9 present antifreeze O-A-548A and 50.1 percent tap water). Padlock installed on radiator pressure cap. Freeze point, -37°F.
20 Jun 67	12152	2075	8	-	Third quarterly inspection. No leaks or defects noted. Removed 8-ounce sample.
13 Jul 67	13212	3135	128	-	Operational inspection. Test coolant drained to repair engine front mount. A coolant loss of 3.5 quarts resulted from seepage at the radiator lower hose. An additional 16 ounces were lost during this maintenance. The test coolant drained was reinstalled after maintenance. Replaced 128 ounces additional test coolant.
23 Oct 67	13385	3312	8	-	Fourth quarterly inspection. No leaks or defects noted. Removed 8-ounce sample.

SUMMARY OF VEHICLE OPERATIONS (Continued)

Date	Odom (mi)	Test Miles	Coolant Added (oz)	Radiator Flow Rate (gpm)	Comments
20 Nov 67	16920	6843	32	-	Visual inspection. No leaks noted. On 5 November 1967, coolant found seeping from crack in radiator upper tank along side vertical mounting brace. Radiator repaired. Replaced 32 ounces of coolant.
20 Dec 67	19193	9116	64	-	Visual inspection. No leaks or defects noted. On 1 December 1967, coolant seeping through crack in radiator upper tank. The radiator was repaired. Replaced 64 ounces of test coolant.
5 Jan 68	20326	10249	8	-	Fifth quarterly inspection. No visible leaks or defects. Removed 8 ounces of coolant. Sample contained heavy rust sediment and was discolored.
20 Apr 68	24336	14259	16	-	Sixth quarterly inspection. No leaks or defects noted. Coolant heavily contaminated and rust color. Removed two 8-ounce samples of coolant.
12 May 68	25124	15047	64	-	Visual inspection. No leaks or defects noted. Coolant level below radiator core. Replaced 64 ounces of test coolant.
23 Jul 68	26849	16772	8	-	Seventh quarterly inspection. No leaks or defects noted. Removed 8-ounce sample.
23 Sep 68	28211	18134	96	-	Visual inspection. No leaks or defects noted. On 5 September 1968, coolant seeps were found at the radiator upper and lower hose. New hose clamps were installed to stop seeps. Replaced 96 ounces of coolant.
31 Oct 68	28264	18187	8	-	Eighth quarterly inspection. No leaks or defects noted. Removed 8 ounces of test coolant for sample analysis.

SUMMARY OF VEHICLE OPERATION (Concluded)

Date	Odom (mi)	Test Miles	Coolant Added (oz)	Radiator Flow Rate (gpm)	Comments
4 Feb 69	28330	18253	0	55	Ninth quarterly and final inspection. No leaks or defects noted. Removed 1-gallon sample test coolant. Sample was rust red color and heavily contaminated. Radiator was removed and flow rate recorded at 55 gallons per minute. Remainder of test coolant was drained and disposed of. Test ended.

Total miles (3 Feb 67 - 3 Feb 69): 18253
Total coolant added (3 Feb 67 - 3 Feb 69): 440 ounces

CHEMICAL ANALYSES OF COOLANT

Test	Minimum	1966 Jul	1966 Dec	1967 Feb[a]	1967 Mar	1967 Jun	1967 Oct	1968 Jan	1968 Apr	1968 Jun	1968 Oct	1969 Feb
∞Truck, Utility, 1/4-Ton, 4x4, IHC Scout, Model 800, USA Reg No. 1R5337												
Coolant solution installed: 50/50 antifreeze, O-A-548A, and tap water with 8.5 ounces of corrosion inhibitor, O-I-490 (5 ounces to each 10 quarts ~~solution~~ WATER)												
Boiling point (°F)	300[b]	-	220	-	-	-	-	-	-	-	-	231.7
Flash point (°F)	230[b]	-	-	-	-	-	-	-	-	-	-	-
Freeze point (°F)												
a. Darbo	-34[c]	-34	0	-34	-33	-28	-52	-42	-36	-34	-36	-37
b. ASTM	-34[c]	-	-	-34	-	-	-	-	-36	-33	-36	-37
c. VU-Chek	-34[c]	-	-	-34	-	-	-	-	-35	-33	-35	-37
pH value	7.5-8.0[c]	-	7.8	7.8	8.75	7.1	7.3	7.3	7.4	7.2	7.2	7.2
Reserve alkalinity[d]	13.5[d]	-	21.5[d]	21.5[d]	10.95[d]	20.8[d]	19.7[d]	19.7[d]	10.1	9.8	9.6	8.53
Insoluble (mg/100 ml)								0.07	1.76	50.8	43.2	-
Chlorides								Pos	Pos	Pos	Pos	Pos
Sulfate								Pos	Pos	Pos	Pos	Pos
Carbonate								Pos	Pos	Pos	Pos	Pos
Test miles		0	1498	262	2675	3027	4768	6391	7758	9157	10568	12016

[a]Test restarted
[b]Undiluted
[c]Diluted
[d]Milliliters of 0.1 normal hydrochloric acid added to 20 milliliters of sample for pH 5.5

CHEMICAL ANALYSES OF COOLANT (Continued)

Test	Minimum	1966 Jul	1966 Dec	1967 Feb	1967 Mar	1967 Jun	1967 Oct	1968 Jan	1968 Apr	1968 Jul	1968 Oct	1969 Feb
Truck, Utility, 1/4-Ton, 4x4, IHC Scout, Model 800, USA Reg No. 1R5339												
Coolant solution installed: Corrosion inhibitor O-I-490 and 100 percent tap water (5 ounces to each 10 quarts water).												
pH value	7.5-8.0	-	8.9	-	-	8.4	8.9	8.8	8.7	8.8	8.75	8.96
Reserve alkalinity[c]	8.7	-	8.8	-	-	-	16.4[d]	15.5[d]	7.7	7.6	7.1	7.4
Insoluble matter (mg/100 ml)	Max. 1.4%	-	17	-	-	-	-	0.07	4.20	58.8	57.6	75.2
Chlorides	Negative	-	Neg	-	-	-	-	Pos	Pos	Pos	Pos	Pos
Sulfates	Negative	-	Neg	-	-	-	-	Pos	Pos	Pos	Pos	Pos
Carbonates	Negative	-	Neg	-	-	-	-	Pos	Pos	Pos	Pos	Pos
Freeze point (+°F)												
Darbo	32	-	-	-	-	30	32	28	30	28	31	30
ASTM	32	-	-	-	-	-	-	-	30	29	30	30
VU-Chek	-	-	-	-	-	-	-	-	31	28	31	30
Test miles		0	2839	4051	4186	5702	7951	9309	11354	12876	14237	15416

[d]Milliliter of 0.1 normal hydrochloric acid for 20 milliliter sample.

CHEMICAL ANALYSES OF COOLANT (Continued)

Test	Minimum	1966 Jul	1966 Dec	1967 Feb	1967 Mar	1967 Jun	1967 Oct	1968 Jan	1968 Apr	1968 Jul	1968 Oct	1969 Feb
Truck, Utility, 1/4-Ton, 4x4, IHC Scout, Model 800, USA Reg No. 1R5347												
Coolant solution installed: Corrosion inhibitor O-I-490 and 100 percent tap water (5 ounces to each 10 quarts of water)												
pH value	7.5-8.0	-	9.0	-	-	9.0	9.0	8.7	8.5	8.75	8.75	8.88
Reserve alkalinity[c]	8.7	-	12.6[d]	-	-	-	17.3[d]	16.8[d]	7.7	7.6	7.5	7.44
Insoluble matter (mg/100 ml)	Max. 1.4%	-	251	-	-	-	-	0.04	3.00	43.2	18.8	21.6
Chlorides	Negative	-	Neg	-	-	-	-	Pos	Pos	Pos	Pos	Pos
Sulfates	Negative	-	Neg	-	-	-	-	Pos	Pos	Pos	Pos	Pos
Carbonates	Negative	-	Neg	-	-	-	-	Pos	Pos	Pos	Pos	Pos
Freeze point (+°F)												
Darbo	32	-	-	-	-	30	34	37	30	30	32	30
ASTM	32	-	-	-	-	-	-	-	30	30	30	30
VU-Chek	-	-	-	-	-	-	-	-	30	28	30	30
Test miles		0	3283	4382	4801	6897	9681	11112	12763	14270	16126	17945

[d] Milliliter of 0.1 normal hydrochloric acid for 10 milliliter sample.

Test	Minimum	1966 Jul	1966 Dec	1967 Feb[a]	1967 Mar	1967 Jun	1967 Oct	1968 Jan	1968 Apr	1968 Jul	1968 Oct	1969 Feb
Truck, Utility, 1/4-Ton, 4x4, IHC Scout, Model 800, USA Reg No. 1R5352												
Coolant solution installed: 50/50 antifreeze O-A-548A and tap water with 8.5 ounces of corrosion inhibitor, O-I-490 (5 ounces to each 10 quarts ~~solution~~ WATER)												
Boiling point (°F)	300[b]	-	230	-	-	-	-	-	-	-	-	232.0
Flash point (°F)	230[b]	-	-	-	-	-	-	-	-	-	-	-
Freeze point (°F)												
Darbo	-34[c]	-34	-28	-34	-34	-44	-58	-46	-34	-32	-34	-25
ASTM	-34[c]	-	-	-	-	-	-	-	-34	-32	-34	-24
VU-Chek	-34[c]	-	-	-	-	-	-	-	-34	-32	-34	-24
pH value	7.5-8.0[c]	-	7.5	8.70	8.70	7.5	7.4	7.3	7.4	7.3	7.25	7.38
Reserve alkalinity[d]	13.5	-	33.6[d]	11.4[d]	11.4[d]	22.7[d]	21.0[d]	20.9[d]	10.7	10.3	10.1	9.0
Insoluble (mg/100 ml)								0.03	3.44	24.0	37.2	-
Chlorides								Pos	Pos	Pos	Pos	Pos
Sulfate								Pos	Pos	Pos	Pos	Pos
Carbonate								Pos	Pos	Pos	Pos	Pos
Test miles		0	3874	4286	860	2051	3222	3508	5094	5743	6796	8359

[d]Milliliter of 0.1 normal hydrochloric acid added to 20 milliliter of sample for pH 5.5.

CHEMICAL ANALYSES OF COOLANT (Continued)

Test	Minimum	1966 Jul	1966 Dec	1967 Feb[a]	1967 Mar	1967 Jun	1967 Oct	1968 Jan	1968 Apr	1968 Jul	1968 Oct	1969 Feb
Truck, Cargo, 3/4-Ton, 4x4, Ford Pick-up, Model F250, USA Reg No. 1N7437												
Coolant solution installed: 50/50 antifreeze O-A-548A and tap water with 8.5 ounces of corrosion inhibitor O-I-490 (5 ounces to each 10 quarts ~~solution~~ WATER)												
Boiling point (°F)	300[b]	-	240	-	-	-	-	-	-	-	-	226.3
Flash point (°F)	230[b]	-	-	-	-	-	-	-	-	-	-	-
Freeze point (°F)												
Darbo	-34[c]	-34	-70+	-34	-34	-38	-44	-34	-28	-14	-18	-10
ASTM	-34[c]	-	-70+	-	-	-	-	-	-28	-14	-18	-10
VU-Chek	-34[c]	-	-	-	-	-	-	-	-28	-14	-19	-10
pH value	7.5-8.0[c]	-	7.2	8.75	8.75	7.4	7.4	7.4	7.3	7.5	7.4	7.52
Reserve alkalinity[d]	13.5	-	40.2[d]	11.51[d]	11.51[d]	21.4[d]	21.7[d]	19.2[d]	10.2	8.7	8.9	8.0
Insoluble (mg/100 ml)								0.04	4.00	9.6	38.0	-
Chlorides								Pos	Pos	Pos	Pos	Pos
Sulfate								Pos	Pos	Pos	Pos	Pos
Carbonate								Pos	Pos	Pos	Pos	Pos
Test miles		0	4180	4613	1135	4914	7594	9900	13186	14286	15951	18657

[d]Milliliter of 0.1 normal hydrochloric acid added to 20 milliliter of sample for pH 5.5.

CHEMICAL ANALYSES OF COOLANT (Continued)

Test	Minimum	1966 Jul	1966 Dec	1967 Feb	1967 Mar	1967 Jun	1967 Oct	1968 Jan	1968 Apr	1968 Jul	1968 Oct	1969 Feb
Truck, Cargo, 3/4-Ton, 4x4, Ford Pickup, Model F250, USA Reg No. 1N7438												
Coolant solution installed: Corrosion inhibitor O-I-490 and 100 percent tap water (5 ounces to each 10 quarts of water)												
pH value	7.5-8.0	-	8.9	-	-	8.7	8 9	8.9	8.7	8.3	8.80	8.94
Reserve alkalinity[c]	8.7	-	8.7	-	-	-	13.4[d]	13.2[d]	6.9	7.6	8.6	8.53
Insoluble matter (mg/100 ml)	Max. 1.4%	-	133	-	-	-	-	0.02	7.60	81.6	38.4	32.8
Chlorides	Negative	-	Neg	-	-	-	-	Pos	Pos	Pos	Pos	Pos
Sulfates	Negative	-	Neg	-	-	-	-	Pos	Pos	Pos	Pos	Pos
Carbonates	Negative	-	Neg	-	-	-	-	Pos	Pos	Pos	Pos	Pos
Freeze point (+°F)												
Darbo	32	-	-	-	-	30	28	28	30	23	30	30
ASTM	32	-	-	-	-	-	-	-	30	24	30	30
VU-Chek	-	-	-	-	-	-	-	-	30	22.5	30	29
Test miles[c]		0	3584	4935	5729	8542	9657	11388	11916	13998	16680	17186

[c]New solution installed 30 June 1967, test miles - 8677.

[d]Milliliter of 0.1 normal hydrochloric acid for 10 milliliter sample.

CHEMICAL ANALYSES OF COOLANT (Continued)

Test	Minimum	1966 Jul	1966 Dec	1967 Feb	1967 Mar	1967 Jun	1967 Oct	1968 Jan	1968 Apr	1968 Jul	1968 Oct	1969 Feb
Truck, Tractor, 5-Ton, 6x6, M52A1, USA Reg No. 5D1140												
Coolant solution installed: Corrosion inhibitor 0 I 490 and 100 percent tap water (5 ounces to each 10 quarts of water)												
pH value	7.5-8.0	-	9.0	-	-	9.0	8.6	8.8	8.7	8.8	8.5	8.61
Reserve alkalinity[a]	8.7	-	5.2	-	-	-	8.9[d]	9.6[d]	3.6	5.2	5.8	5.18
Insoluble matter (mg/100 ml	Max. 1.4%	-	521	-	-	-	-	0.20	10.16	201.2	144.8	265.2
Chlorides	Negative	-	Neg	-	-	-	-	Pos	Pos	Pos	Pos	Pos
Sulfates	Negative	-	Neg	-	-	-	-	Pos	Pos	Pos	Pos	Pos
Carbonates	Negative	-	Neg	-	-	-	-	Pos	Pos	Pos	Pos	Pos
Freeze point (+°F)												
Darbo	32	-	-	-	32	30	28	28	30	31	29	28
ASTM	32	-	-	-	-	-	-	-	30	30	29	27.5
VU-Chek	32	-	-	-	-	-	-	-	31	31	29	28
Test miles[e]		0	4374	6118	159	2772	7825	7972	11384	12382	13554	13629

[e]New solution installed 23 February 1967. Test restarted. Test miles - 6117.5

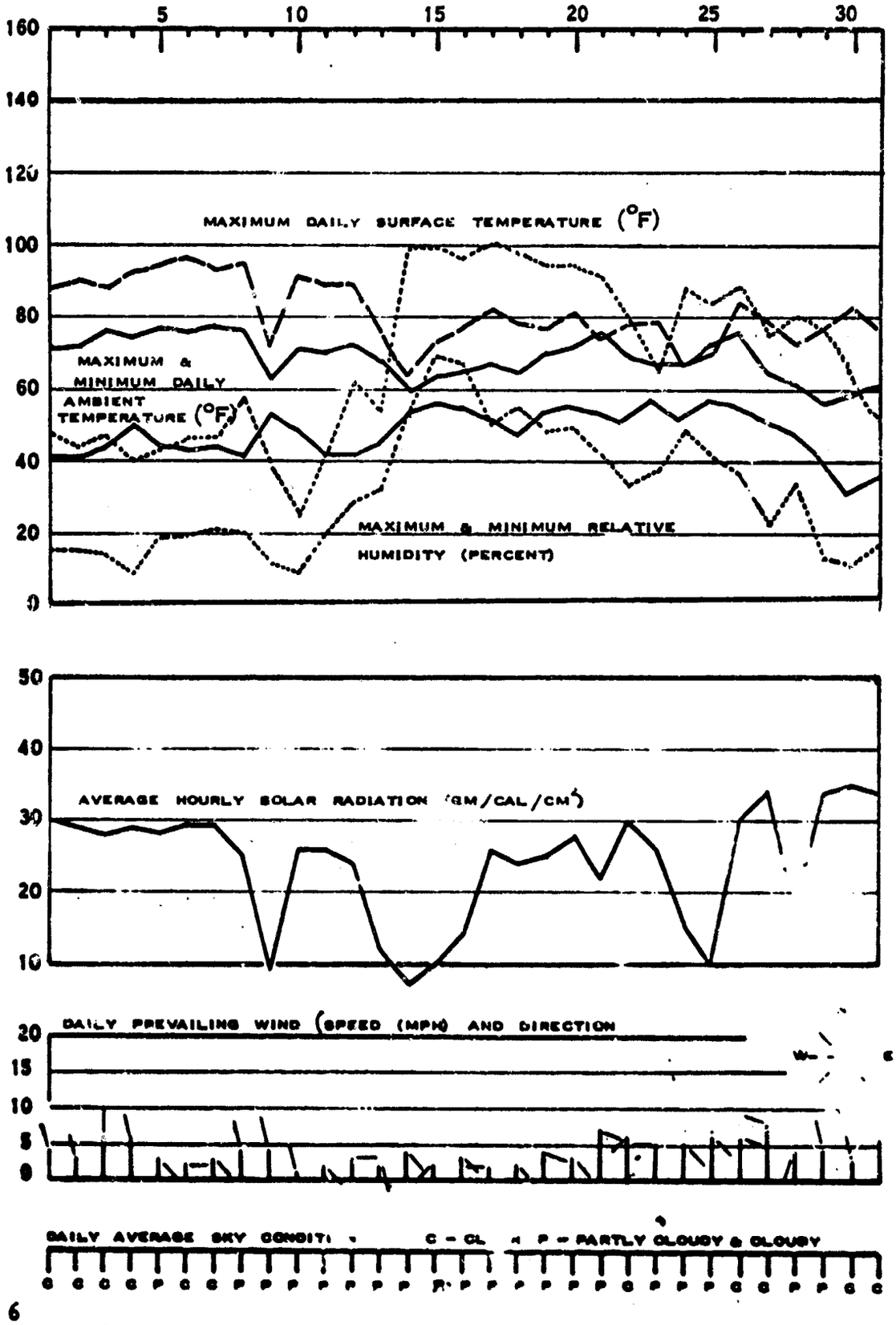
[d]Milliliter of 0.1 normal hydrochloric acid for 10 milliliter sample.

CHEMICAL ANALYSES OF COOLANT (Concluded)

Test	Minimum	1966 Jul	1966 Dec	1967 Feb[a]	1967 Mar	1967 Jun	1967 Oct	1968 Jan	1968 Apr	1968 Jul	1968 Oct	1969 Feb
Truck, Tractor, 5-Ton, 6x6, M52A1, USA Reg No. 5D1149												
Coolant solution installed: 50/50 antifreeze O-A-548A and tap water with 22 ounces of corrosion inhibitor O-I-490 (5 ounces to each 10 quarts of ~~solution~~ water). Capacity - 14 quarts.												
Boiling point (°F)	300[b]	-	237.5	-	-	-	-	-	-	-	-	230.8
Flash point (°F)	230[b]	-	-	-	-	-	-	-	-	-	-	-
Freeze point (°F)												
Darbo	-34[c]	-34	-70+	-34	-34	-40	-52	-42	-45	-43	-38	-42
ASTM	-34[c]	-	-	-	-	-	-	-	-44	-42	-39	-42
VU-Chek	-34[c]	-	-	-	-	-	-	-	-45	-42	-40	-42
pH value	7.5-8.0[c]	-	7.3	7.8	8.75	7.3	7.4	7.2	7.3	7.2	7.15	7.2
Reserve alkalinity[a]	13.5	-	32.8[d]	13.5[d]	11.68[d]	32.2[d]	23.2[d]	20.4[d]	10.2	9.7	9.4	9.5
Insoluble matter (mg/100 ml)								0.16	4.68	4.4	99.6	-
Chlorides								Pos	Pos	Pos	Pos	Pos
Sulfates								Pos	Pos	Pos	Pos	Pos
Carbonates								Pos	Pos	Pos	Pos	Pos
Test miles	-	0	4445	6013	126	2075	3312	10249	14259	16772	18187	18253

[d] Milliliters of 0.1 normal hydrochloric acid added to 20 milliliters of sample for pH 5.5.

YUMA PROVING GROUND, YUMA, ARIZONA
METEOROLOGICAL SUMMARY FOR JANUARY 1969



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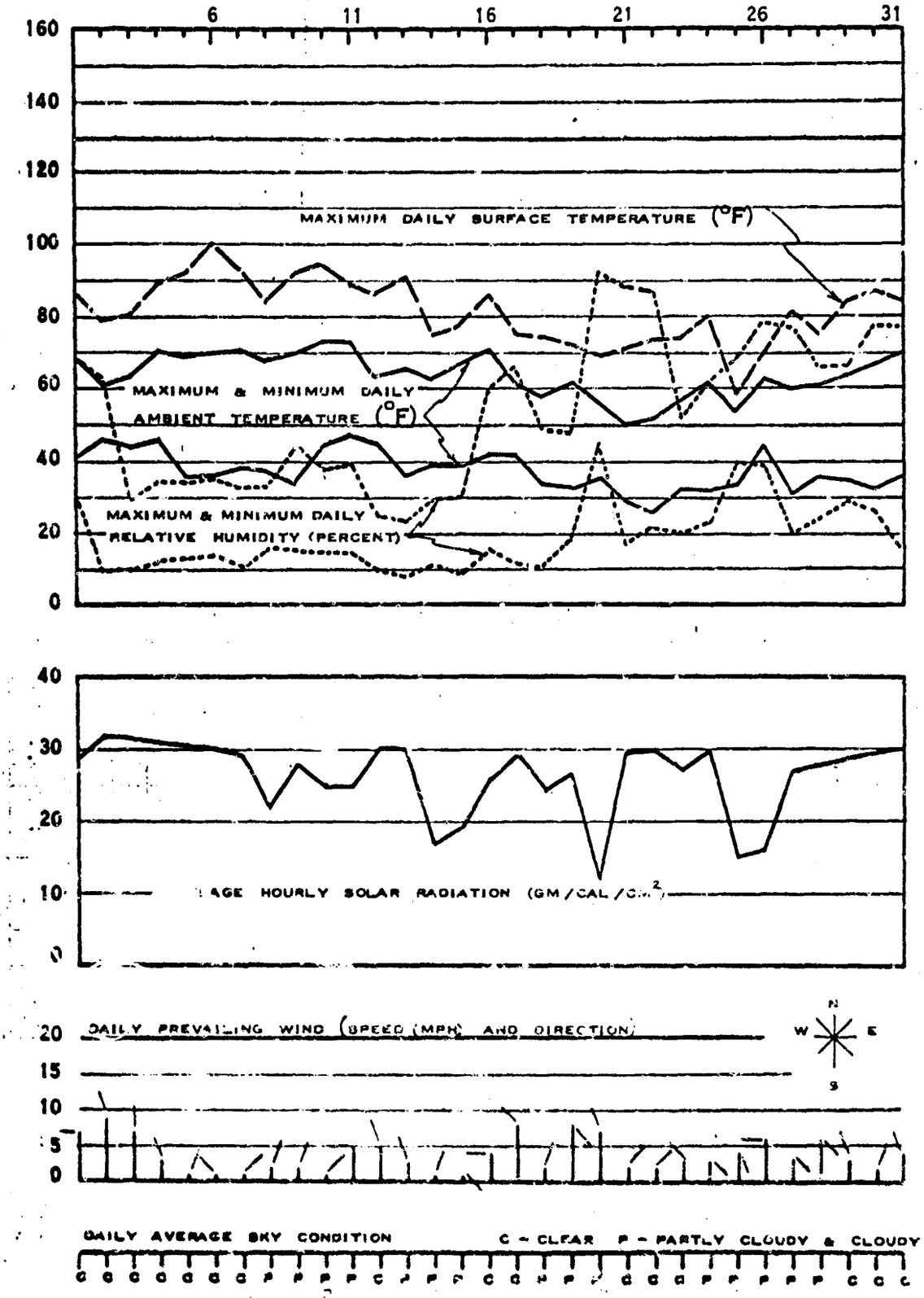
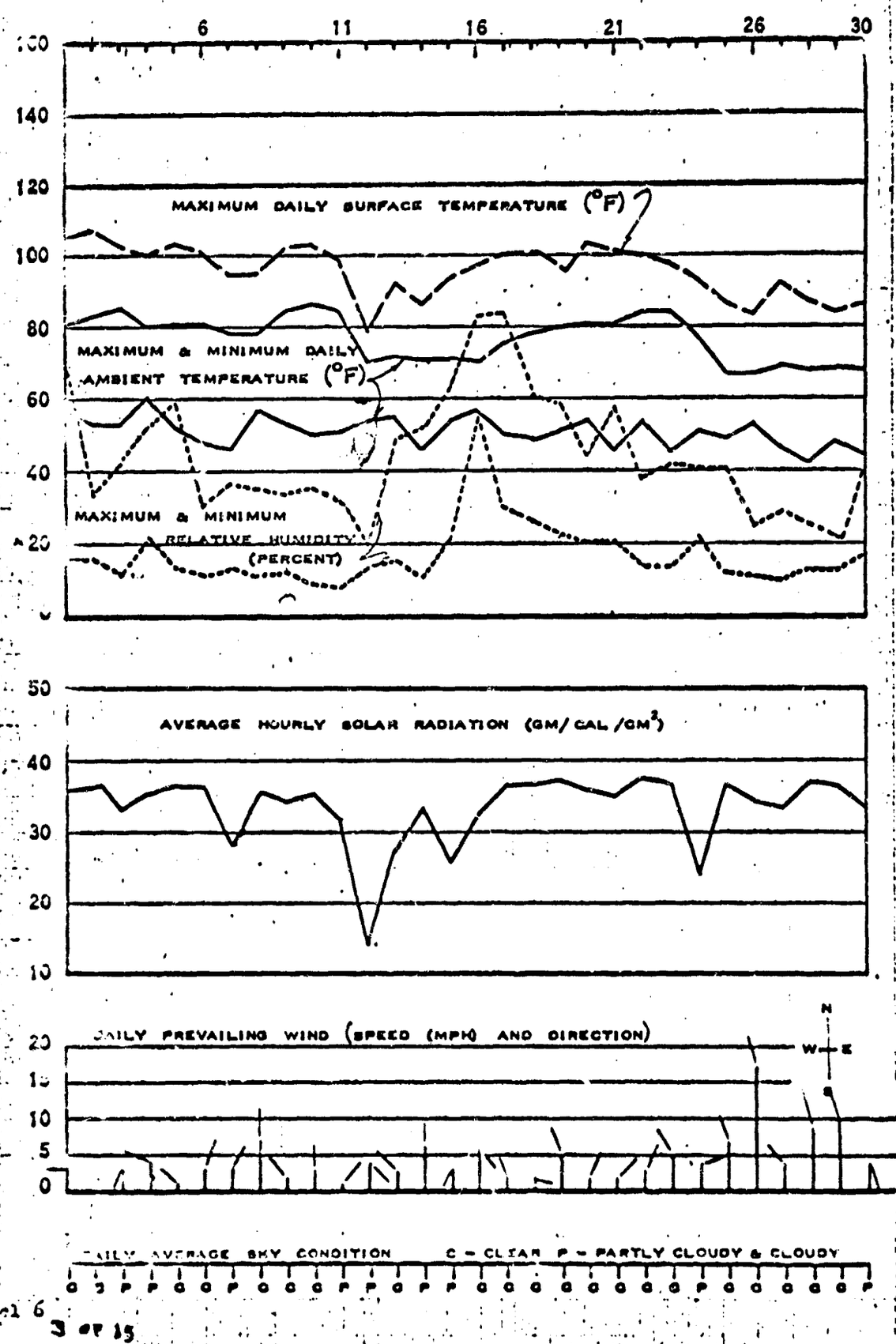
YUMA PROVING GROUND, YUMA, ARIZONA
METEOROLOGICAL SUMMARY FOR DECEMBER 1968



YUMA PROVING GROUND, YUMA, ARIZONA
METEOROLOGICAL SUMMARY FOR NOVEMBER 1968



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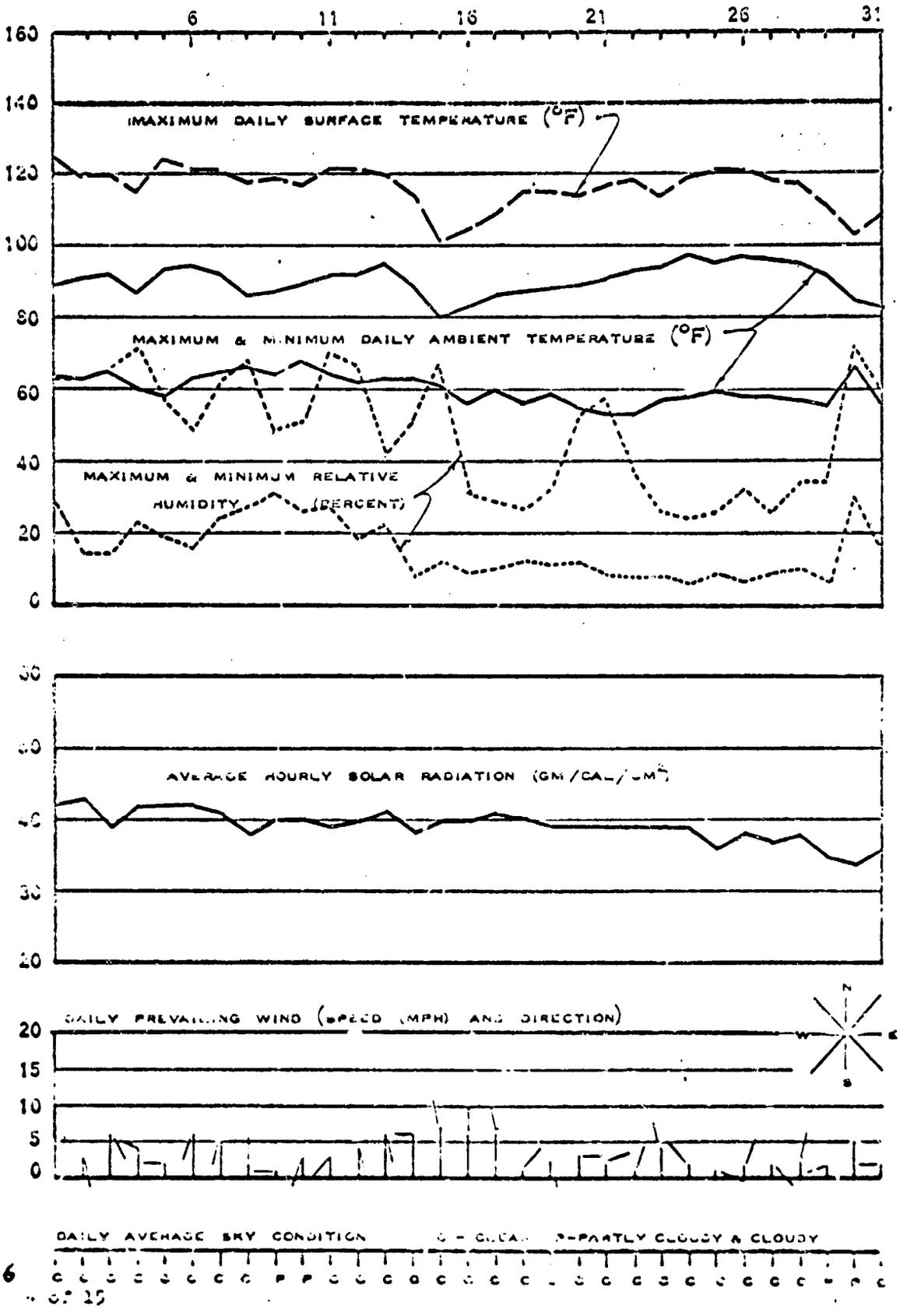
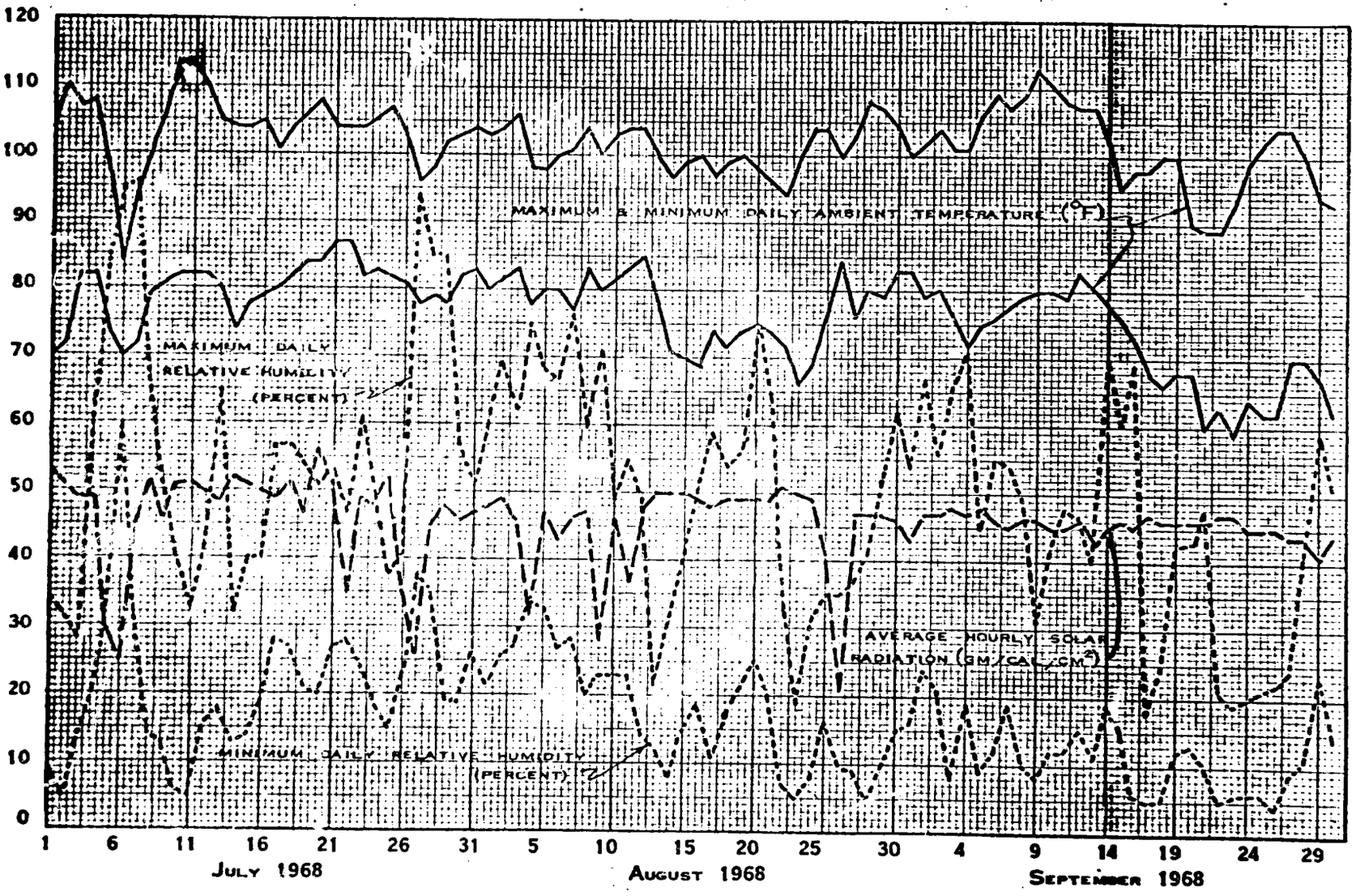
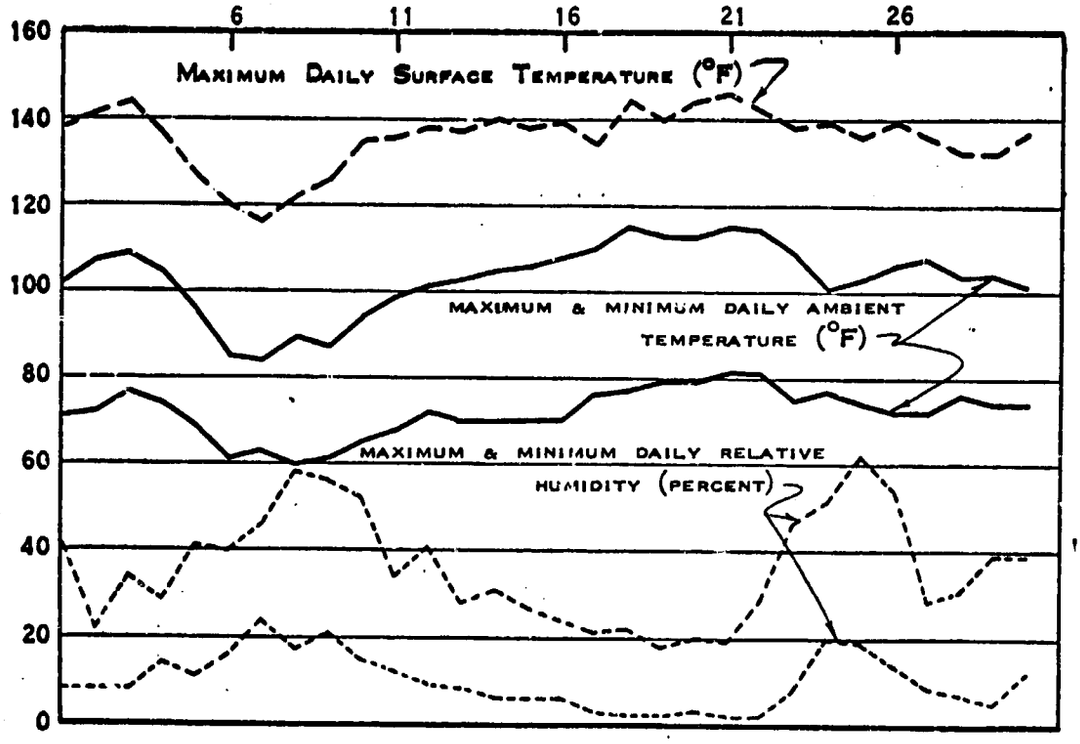
YUMA PROVING GROUND, YUMA, ARIZONA
METEOROLOGICAL SUMMARY FOR OCTOBER 1968

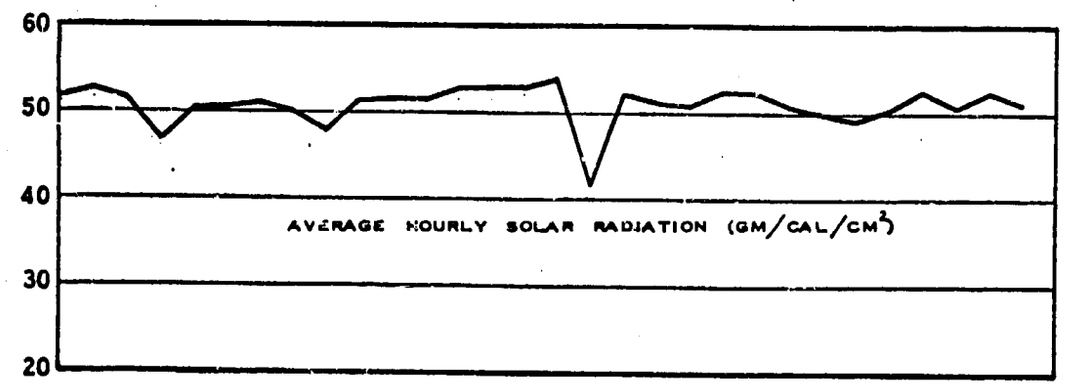


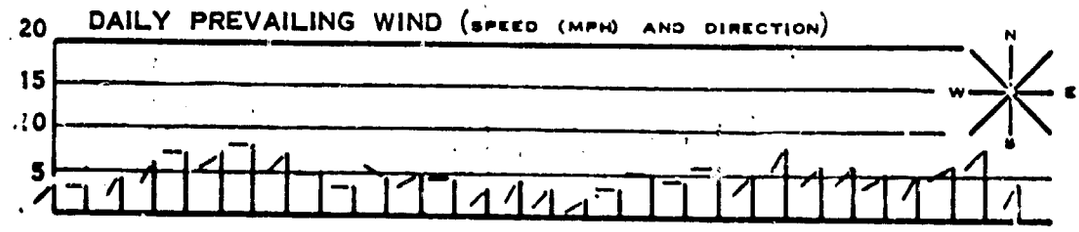
QUARTERLY METEOROLOGICAL SUMMARY
(Ambient Temperature, Relative Humidity and Solar Radiation)
Yuma Proving Ground
Yuma, Arizona

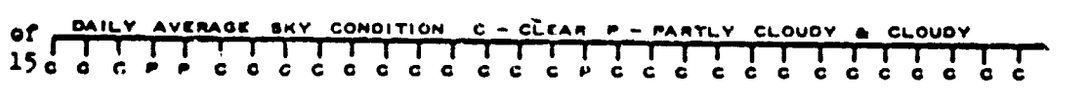


YUMA PROVING GROUND, YUMA, ARIZONA
METEOROLOGICAL SUMMARY FOR JUNE 1968

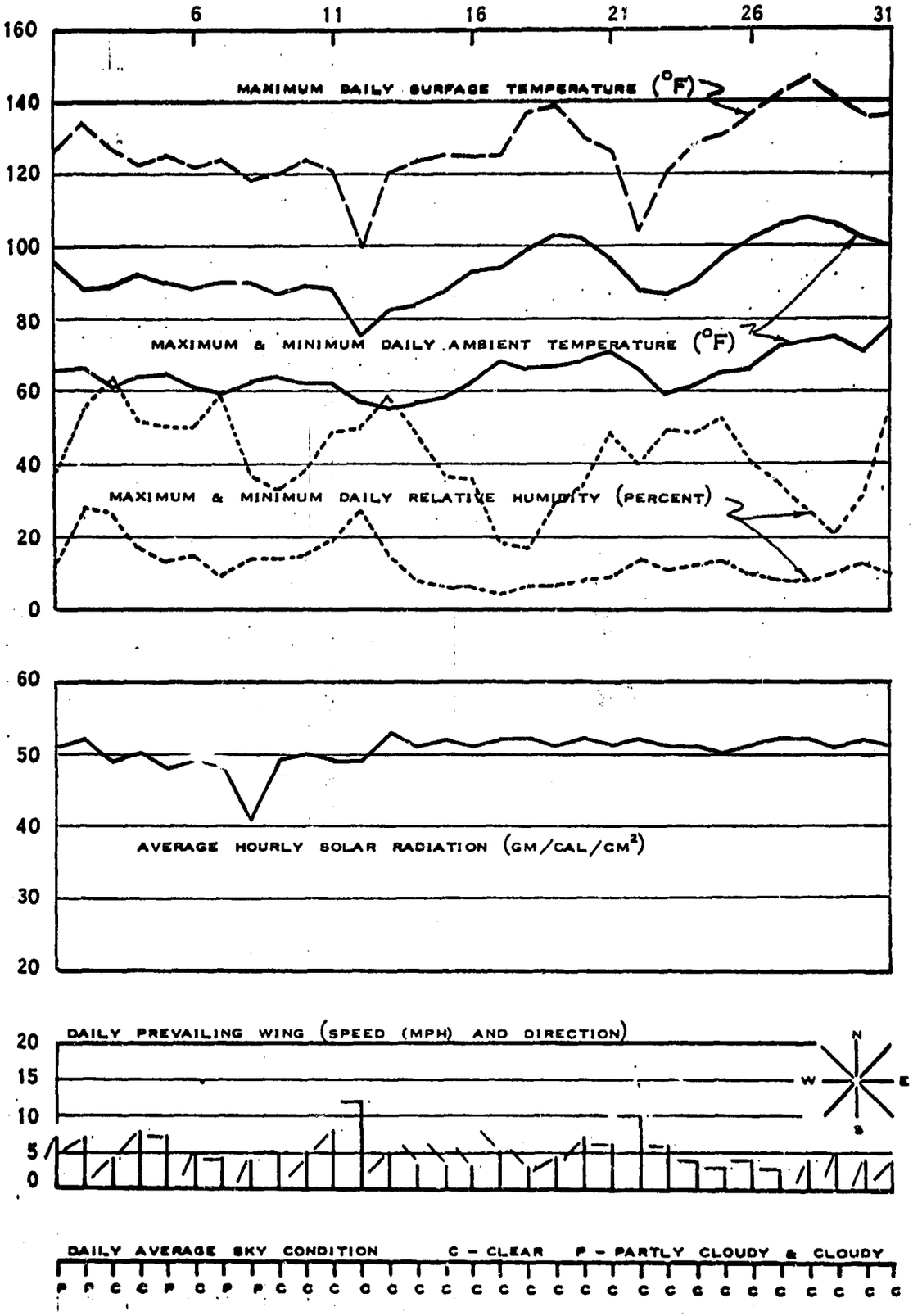








YUMA PROVING GROUND, YUMA, ARIZONA
METEOROLOGICAL SUMMARY FOR MAY 1968



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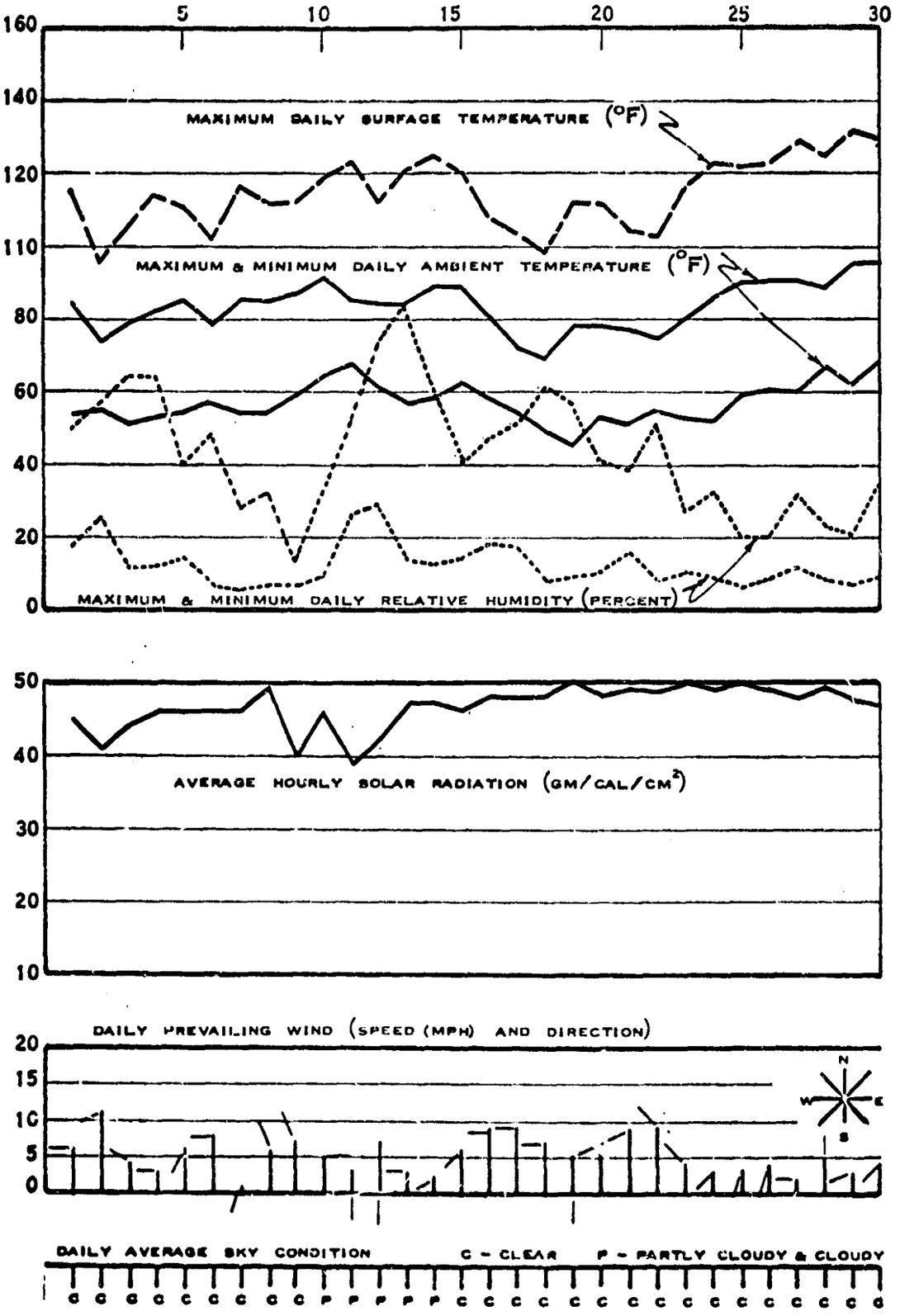
YUMA PROVING GROUND, YUMA, ARIZONA
METEOROLOGICAL SUMMARY FOR APRIL 1968

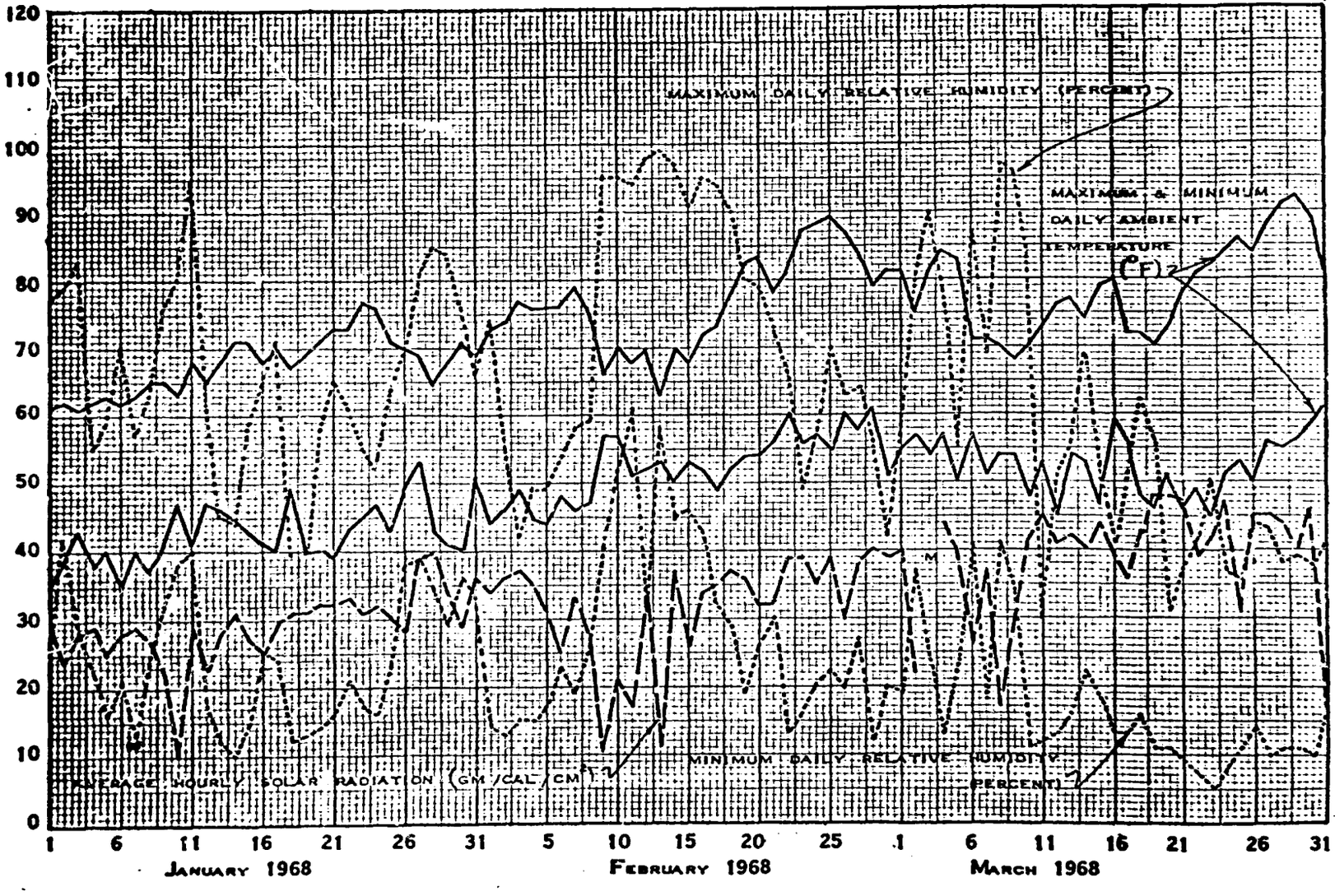


QUARTERLY METEOROLOGICAL SUMMARY

(AMBIENT TEMPERATURE, RELATIVE HUMIDITY AND SOLAR RADIATION)

YUMA PROVING GROUND

YUMA, ARIZONA

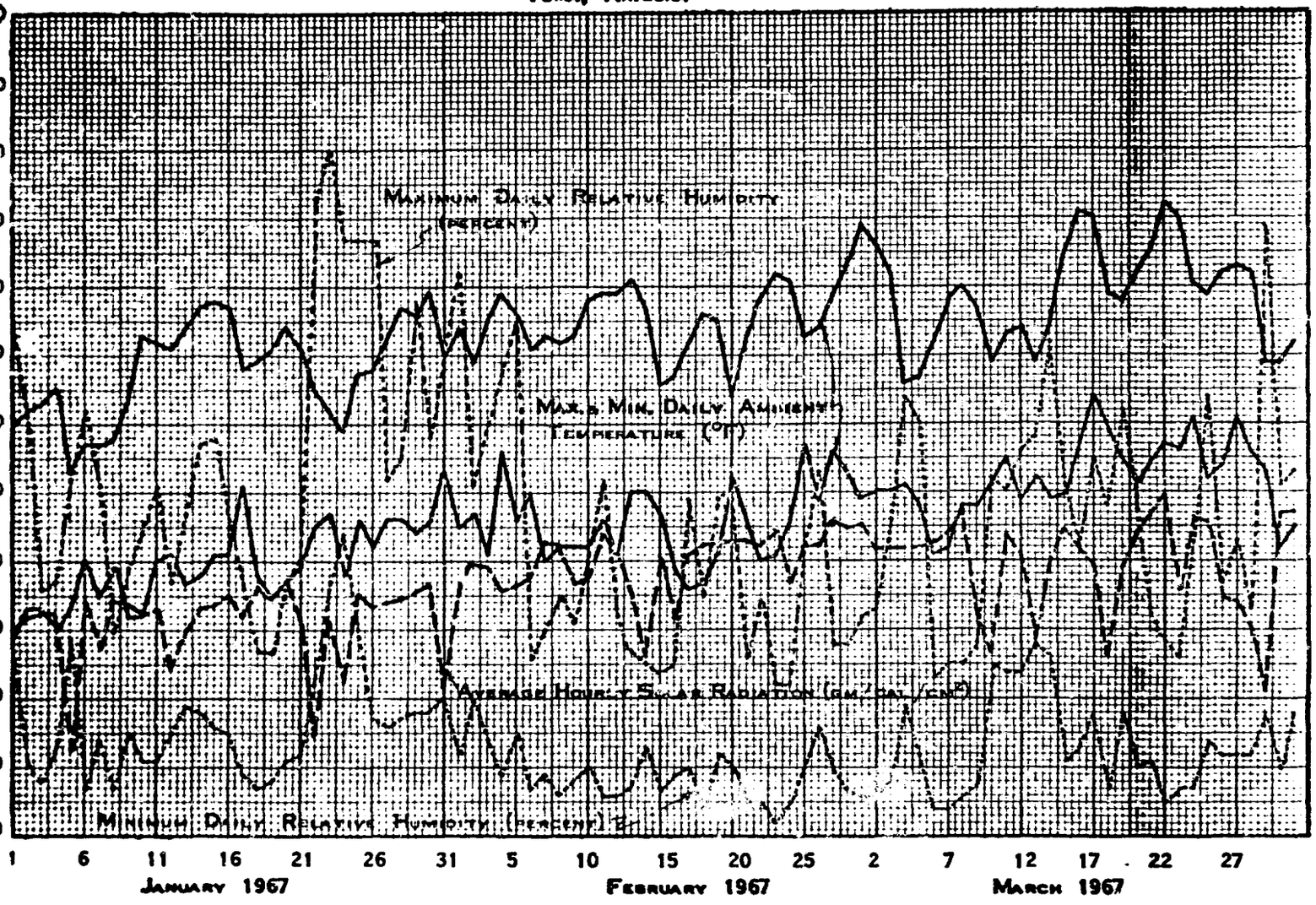


QUARTERLY METEOROLOGICAL SUMMARY

(Ambient Temperature, Relative Humidity and Solar Radiation)

Yuma Proving Ground

Yuma, Arizona

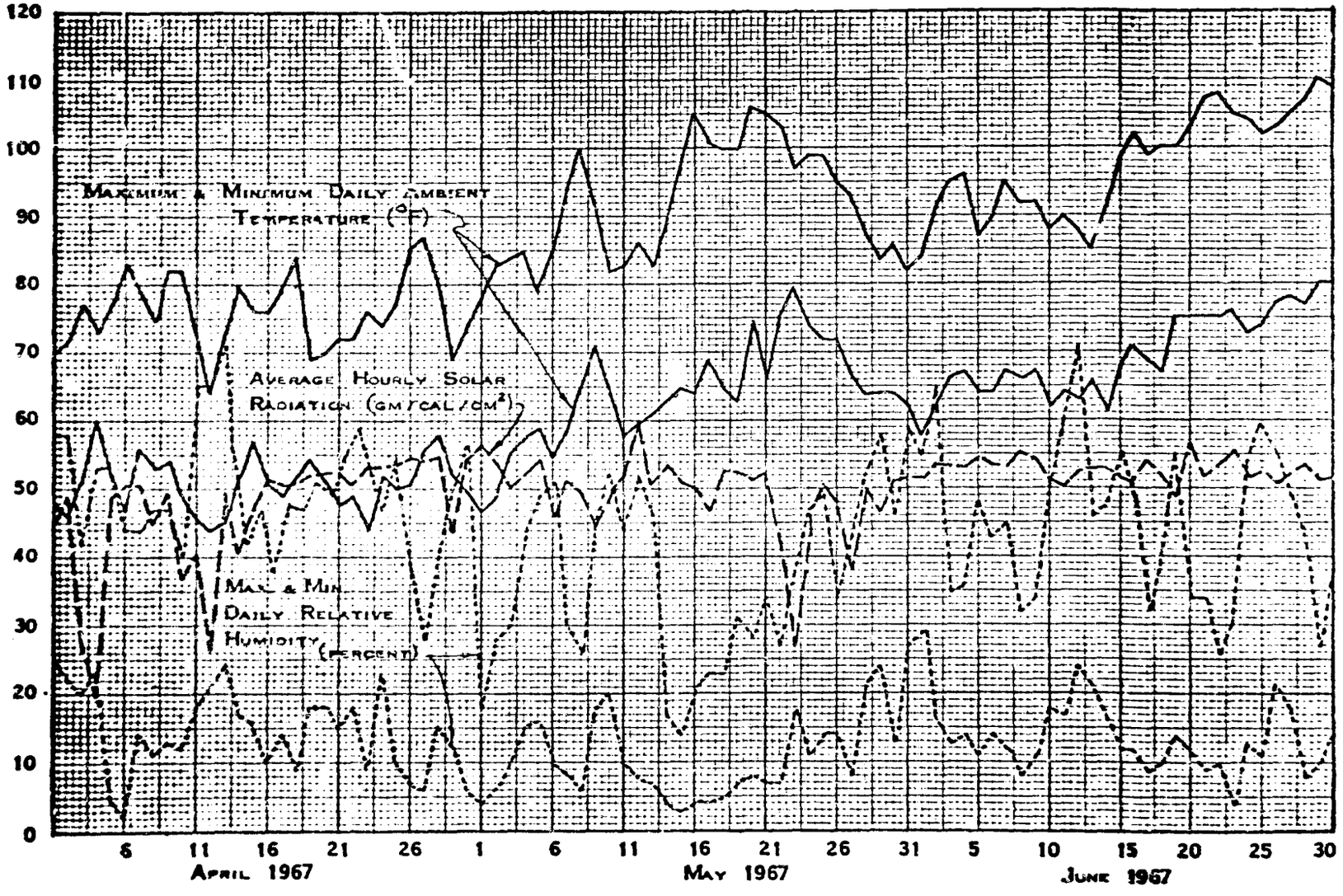


QUARTERLY METEOROLOGICAL SUMMARY

(Ambient Temperature, Relative Humidity and Solar Radiation)

Yuma Proving Ground,

Yuma, Arizona

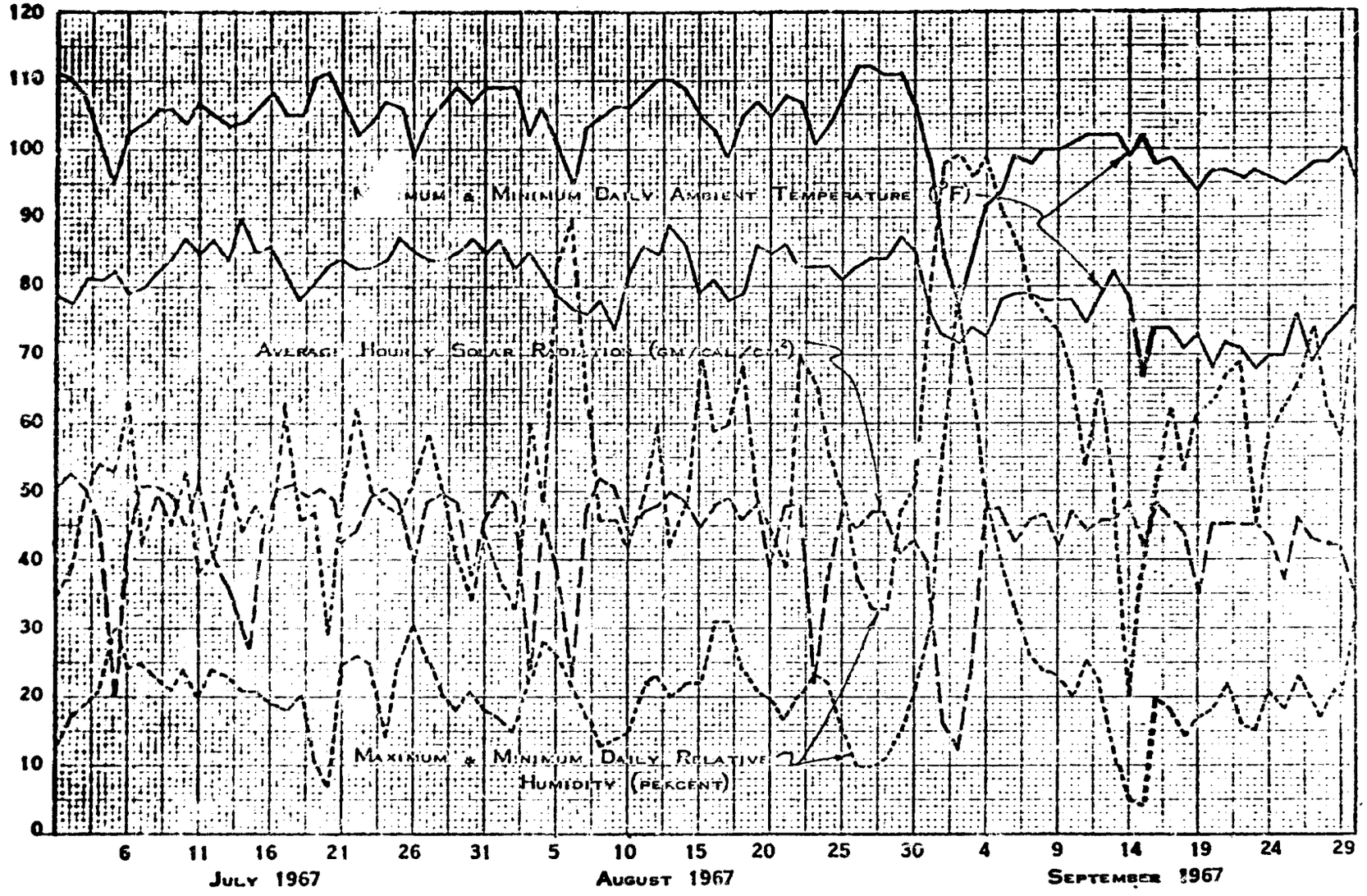


QUARTERLY METEOROLOGICAL SUMMARY

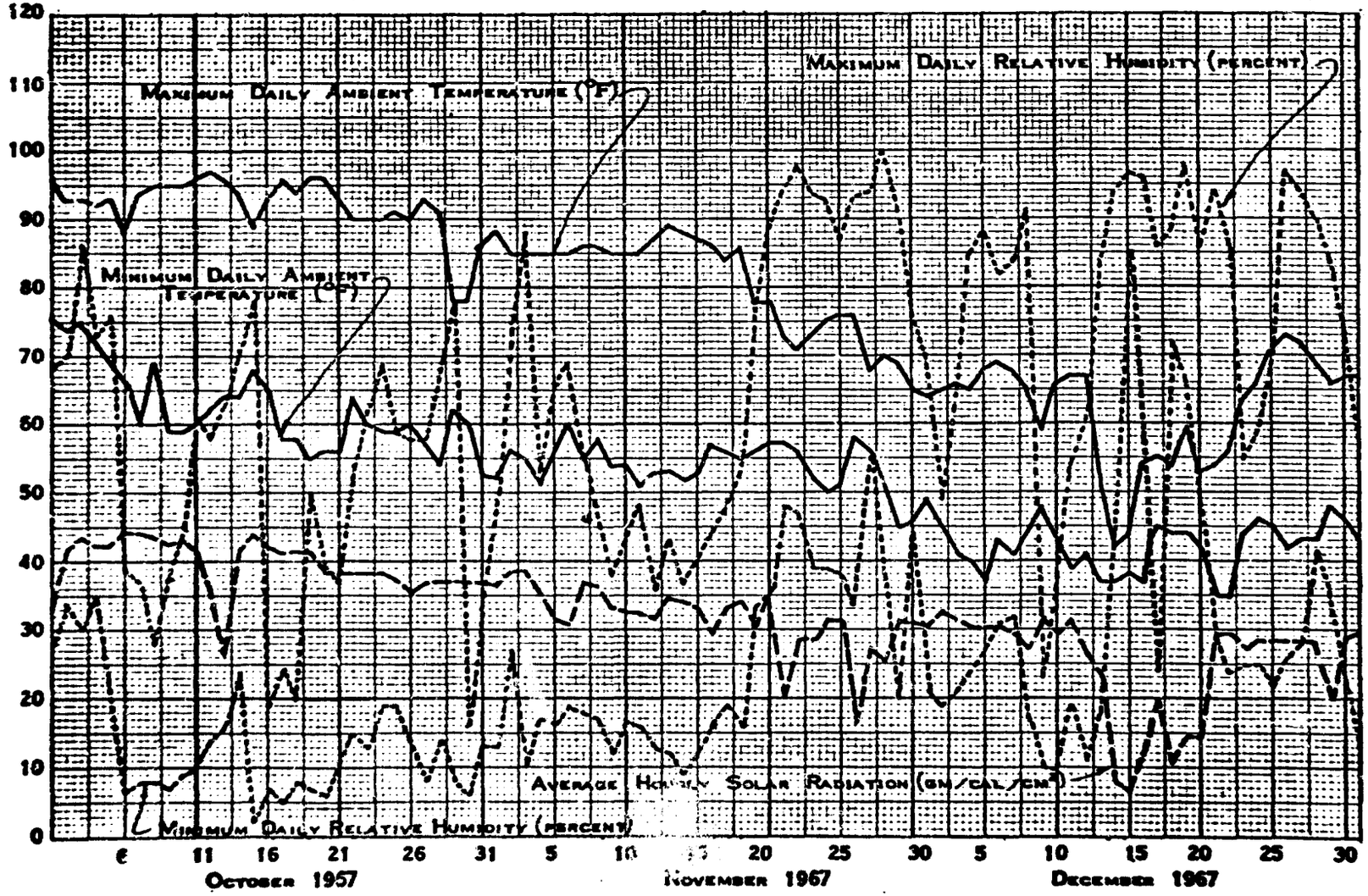
(Ambient Temperature, Relative Humidity and Solar Radiation)

Yuma Proving Ground

Yuma, Arizona



QUARTERLY METEOROLOGICAL SUMMARY
(Ambient Temperature, Relative Humidity and Solar Radiation)
Yuma Proving Ground
Yuma, Arizona



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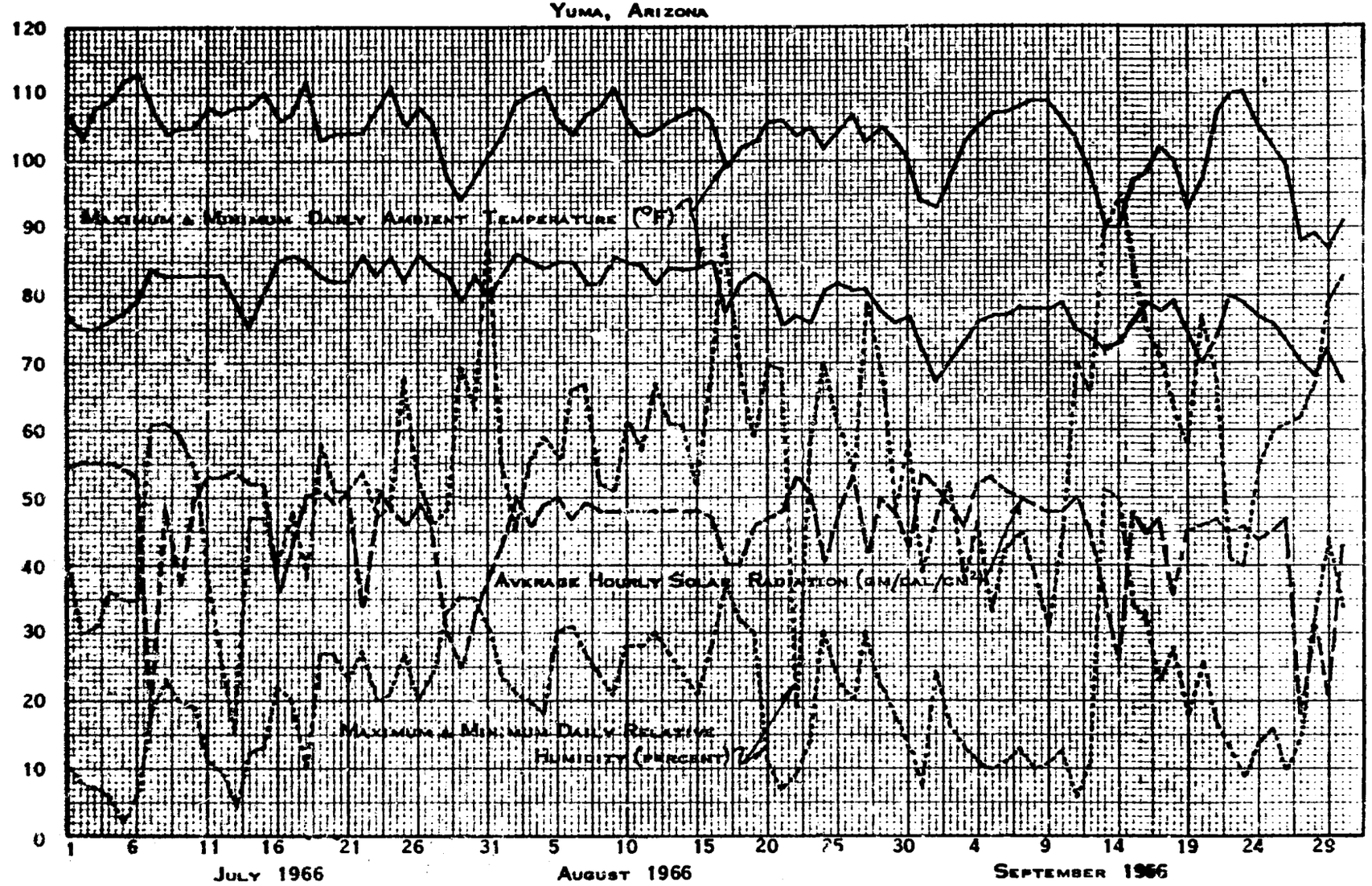
QUARTERLY METEOROLOGICAL SUMMARY

(Ambient Temperature, Relative Humidity and Solar Radiation)

Yuma Proving Ground

Yuma, Arizona

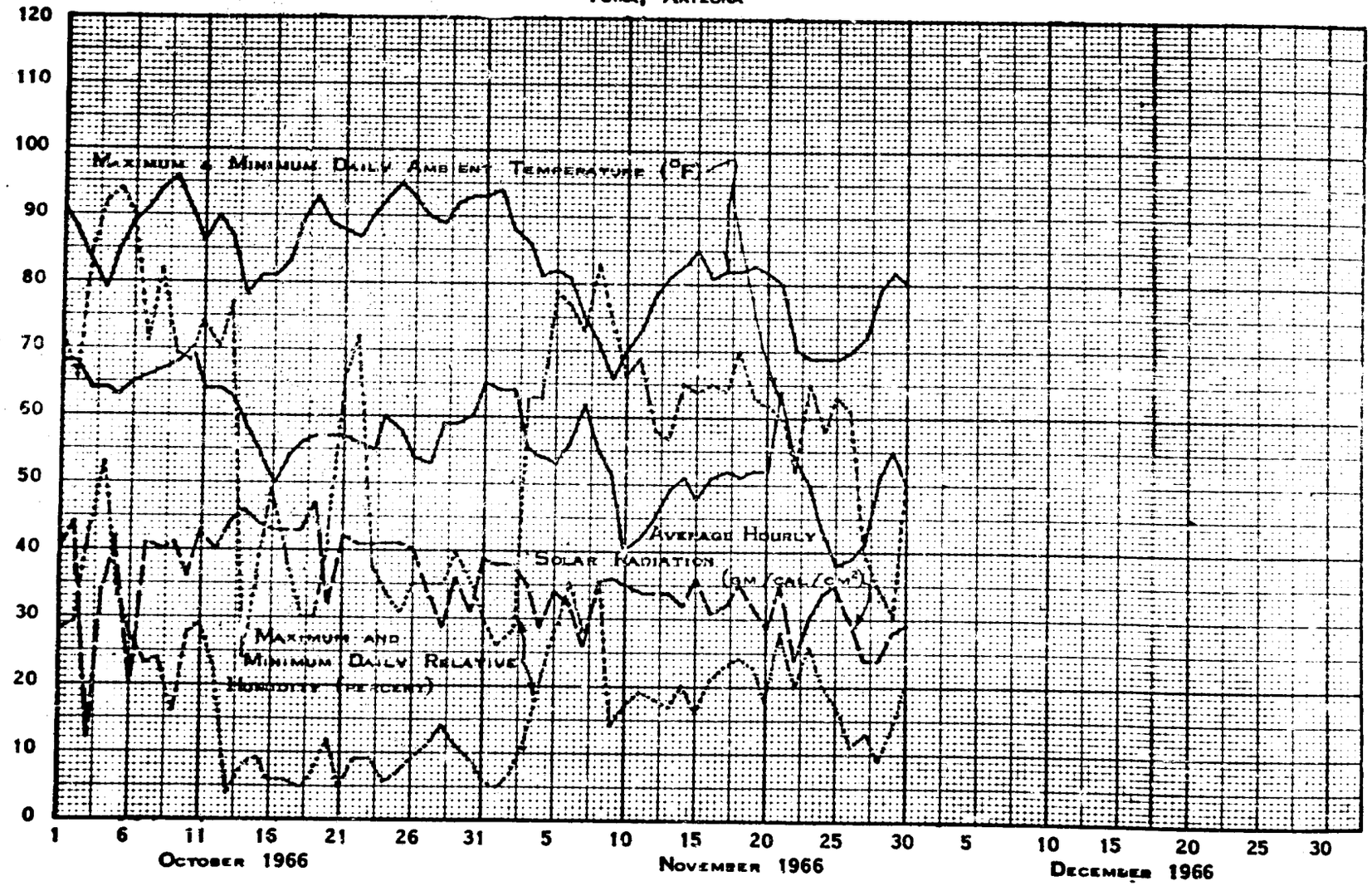


QUARTERLY METEOROLOGICAL SUMMARY

(AMBIENT TEMPERATURE, RELATIVE HUMIDITY & SOLAR RADIATION)

YUMA PROVING GROUND

YUMA, ARIZONA



TPR AND CHANGES

AMXCC-AC 15 June 1966

SUBJECT: Two-Year Test of Antifreeze - Specification O-A-548

TO: Commanding Officer
Yuma Proving Ground
ATTN: STEYP-TAU - Mr. Chapin
Yuma Proving Ground, Arizona

1. Inclosed per telecon 8 June 1966 between Mr. Chapin and Mr. Jordan of this laboratory are specifications pertinent to subject test.

2. This test is being conducted to verify the section in the revision of TB-ORD-651 pertaining to extending the use of antifreeze. Up to the present time antifreeze has been drained and discarded after each winter season. Previous experience indicates that this is the best policy due to lack of control of the coolant system by using personnel. By exercising closer control, it is believed that the extended use of antifreeze may be feasible.

3. The following additional minor changes in test plan are authorized:

(a) Page 11 - Test Procedure - For control vehicles add inhibited water only when necessary.

(b) Para 4 - Data Required - Quarterly check on freeze point, RA, and pH of test solutions. (These tests will be conducted at Yuma Proving Ground in addition to those conducted at Coating & Chemical Laboratory.)

FOR THE COMMANDER:

2 Ins
1 - Spec O-A-548a
2 - Spec O-1-490a

HARRY L. AMMLUNG
Deputy Technical Director

Incl 7
Page 1 of 10

DEPARTMENT OF THE ARMY HLAmmlung/mrb/278-3606
U.S. Army Coating and Chemical Laboratory
Aberdeen Proving Ground, Maryland 21005

AMXCC-AO 2 June 1966

SUBJECT: Two-Year Test of Anti-Freeze, Specification O-A-548

TO: Commanding Officer
Yuma Proving Ground
ATTN: STEYP-TAU (Mr. Chapin)
Yuma, Arizona 85364

1. Reference is made to letter from ATAC, SMOTA-RTT, to USATECOM, AMSTE-TA, dated 24 May 1966, subject as above.

2. Inclosed are modifications to test plan inclosed in subject correspondence.

3. This laboratory has been authorized to deal directly with your station on the performance of this program by AMSTE-GE.

4. It is requested that the modified test plan be reviewed in a cost estimate furnished as soon as possible.

FOR THE COMMANDER:

2 Incl
as

/s/ C. F. Pickett
/t/ C. F. PICKETT
Technical Director

Cy furnished:
AMSTE-GE
Mr. Hartwell

Incl 1
Page 2 of 10

MODIFICATIONS TO TEST PLAN FOR TWO YEAR TEST OF

ANTIFREEZE, SPECIFICATION O-A-548A

SUPPLEMENT 1, 13 May 1966

1. All references to 6 oz. of O-1-490a will be changed to 5 oz.
2. Weekly check of freeze point will be changed to quarterly.
3. Yuma will furnish quarterly memo reports of the progress of test.
4. References to engine operating temperatures will be deleted.

DEPARTMENT OF THE ARMY
United States Army Tank-Automotive Center
Warren, Michigan 48090

SMOTA-RTT 24 May 1966

SUBJECT: Two-Year Test of Anti-Freeze, Specification O-A-548

TO: Commanding General
U.S. Army Test & Evaluation Command
ATTN: AMSTE-TA-M
Aberdeen Proving Ground, Maryland 21005

1. Reference is made to the following correspondence:

a. Original Test Program, Subject: Summer Test of Anti-Freeze O-A-548.

b. Letter from ATAC, SMOTA-RTT to USATECOM, AMSTE-TA, dated 28 March 1966, Subject: Request for Cost Estimate for Test of Anti-Freeze O-A-548.

c. Letter from USATECOM, AMSTE-GE, dated 2 May 1966, Subject: Cost Estimate for Test of Anti-Freeze O-A-548.

2. It is requested that the inclosed Supplement No. 1 be incorporated into the original test program.

3. The test is scheduled to be performed at the Yuma Proving Ground, commencing June 1966, and to be completed in the fall of 1968.

4. Aberdeen Proving Ground, Coating & Chemical Laboratory will perform the following:

a. Supply all material.

b. Perform all chemical and physical analysis.

c. Monitor the project.

SMOTA-RTT 24 May 1966
SUBJECT: Two-Year Test of Anti-Freeze, Specification O-A-548

5. ATAC, SMOTA-ROMG, is responsible for:

a. Initial test program plan.

b. Funding all labor, material, and contractual costs.

c. Provide test coordinator.

6. It is requested that the Reliability Engineering Branch be provided with a Cost Estimate for any additional funds required to perform the subject test in accordance with the inclosed Supplement No. 1.

FOR THE COMMANDER:

1 Incl
as (dupe)

/s/ Wilbert Simkovitz
/t/ Chief, Reliability Eng Branch
Technical Support Division
Rsch & Eng Directorate

Copies furnished:
APG - USATECOM, AMSTE-GE, w/Incls
APG - C & CL, w/Incl
YPG - STEYP-MP, w/Incl
YPG - STEYP-TAU, w/Incls
YPG - STEYP-RTT, Frank Unger
ATAC R&E Liaison Rep, w/Incl

REVISED TEST PROGRAM

SUPPLEMENT 1

13 May 1966

SUBJECT: Two Year Test of Antifreeze, Specification O-A-548

OBJECTIVE:

To determine what adverse effects, if any, to leave antifreeze in vehicles through high desert temperatures, and further investigate the potentiality of extending the use of antifreeze to two years.

MATERIAL:

1. Eight test vehicles as follows:
   a. Two M52A2
   b. Two M37
   c. Four I.H.C. Scouts
2. Two 55 gal. drums of antifreeze, Specification O-A-548, Type 1.
3. Fifty 6 oz. packages of corrosion inhibitor, Specification O-1-490a.
4. Twelve cleaning kits for cooling systems (FSN 6850-598-7328).
5. Three syringe type hydrometers or Darbo Freeze Testers.

TEST PROCEDURE:

1. Vehicles will be divided into two groups as follows:
   a. <u>Control Group</u>
      (1) One M52A2
      (2) One M37
      (3) One I.H.C. Scout
   b. <u>Antifreeze Group</u>
      (1) One M52A2
      (2) One M37
      (3) Three I.H.C. Scouts

2. Prior to test, all cooling systems shall be cleaned, using the cleaning compound kit (FSN 6850-598-7328). Procedures as outlined in TB-ORD-651 will be adhered to. Cooling system shall be thoroughly inspected and any unserviceable components shall be replaced. All deficiencies should be corrected.

3. Install new thermostats set at 180°F prior to test.

4. The control group shall have tap water plus corrosion inhibitor, Spec. O-I-490a (6 oz. to each 10 quarts of water) in their cooling systems.

5. The antifreeze group shall have a 50/50 ratio by volume of antifreeze, Spec. O-A-548a and tap water. To this shall be added corrosion inhibitor (6 oz. to each 10 quarts of water).

6. When adding corrosion inhibitor to cooling systems of all vehicles, the inhibitor should be dissolved in warm water and poured into the radiator while engine is idling.

7. No corrosion inhibitor shall be added after test has been initiated and for the duration of the project.

8. Only fill the radiator to proper level, being careful not to overfill. This applies to original solutions and also the make-up or top-off materials.

9. Keep radiators at proper level by adding solutions as necessary to replace evaporation loss, small leaks, etc.

10. Drastic losses of coolant such as large leaks in radiator, hoses or engine block, vehicle will be considered deadlined for the balance of the project.

11. For control vehicles add water only when necessary.

12. For antifreeze vehicles add 50/50 solution of water and antifreeze when necessary.

SAMPLES REQUIRED:

All samples will be sent to U.S. Army Coating and Chemical Laboratory (C&CL), Aberdeen Proving Ground, Maryland (APG).

Prior to Test

One gallon sample of antifreeze, Spec. O-A-548a.

One gallon of tap water representing that used in test.

One 6 oz. sample of corrosion inhibitor, Spec. O-A-548a.

One sample cleaning kit (FSN 6850-598-7328).

During Test

At start of test and every 90 days thereafter, a four ounce sample will be obtained from each vehicle cooling system.

Antifreeze solution samples will be checked for ph, reserve alkalinity and freeze point. Water solutions for chemical analysis as deemed necessary. NOTE: Any other sample analysis will be at the discretion of APG, C&CL.

DATA REQUIRED:

1. Odometer reading at start and conclusion of each work day.

2. Peak ambient and engine operating temperatures daily.

3. All additions to all cooling systems including reasons for such action.

4. Weekly check on freeze point of antifreeze solution with hydrometer or Darbo freeze tester.

5. Final report within 90 days of conclusion of test.

PROJECT ENGINEER
/s/ James H.G. DeCroot

TEST PROGRAM

SUBJECT: Summer Test of Anti-Freeze O-A-548

OBJECTIVE:

To determine what adverse effects if any, to leave anti-freeze in vehicles through high desert temperatures, and further investigate the potentiality of extending the use of anti-freeze to two years.

MATERIAL:

Ten vehicles as noted below:

Two XM291E2, 2 M54A2, 2 M106-E1, 4 IHC Scouts. These vehicles were selected since they have already been designated for other engineering tests at YPG for 1966. Anti-freeze Ethylene Glycol-Inhibited, Type I.

TEST PROCEDURE:

1. One each of the XM291E2, M54A2 and M106E1 plus two of the IHC scout vehicles shall have tap water plus the corrosion inhibitor in their cooling systems now specified by present existing regulations. These will be used as control vehicles.

2. The remaining five vehicles shall have a 50/50 ratio by volume of ethylene glycol, Specification O-A-548, Type I and water in the cooling system at the initiation of and during the entire test.

3. All vehicles shall be run as deemed necessary for the prime engineering tests; however, the following data is required on a daily basis for the anti-freeze test.

a. Odometer reading at conclusion of work day.

b. Engine operating and ambient temperatures (engine gage reading and peak ambient temperature for the day).

c. All additions to cooling system when necessary, and water and required corrosion inhibitor to control vehicles and 50/50 by volume anti-freeze, Specification O-A-548, Type I and water to test vehicles.

4. At end of test a gallon sample of coolant solution shall be taken from all test vehicles and sent to ATAC, SMOTA-RCM.3.

5. ATAC test coordinator for this project is Mr. J. DeGroot, SMOTA-RCM.3, Extension 2-9132.

6. Final letter report at close of test.

REFERENCE: DF from SMOTA-RCM, dated 12-2-66.

DEPARTMENT OF THE ARMY
YUMA PROVING GROUND
Yuma, Arizona 85364

STEYP-TAU

SUBJECT: Errata to Tenth and Final Letter Report on Research Test of Antifreeze, Specification O-A-548A, Type 1, USATECOM Project No. 7-6-0716-03, dated 25 April 1969.

Commanding General, U.S. Army Test and Evaluation Command, ATTN: AMSTE-GE, AMSTE-TA, Aberdeen Proving Ground, Maryland 21005
Commanding General, U.S. Army Tank-Automotive Command, ATTN: AMSTA-RCM.3, AMSTA-RTT, Warren, Michigan 48090
Commanding Officer, U.S. Army Coating and Chemical Laboratory, ATTN: AMXCC-AO, Aberdeen Proving Ground, Maryland 21005
Commander, Defense Documentation Center for Scientific and Technical Information, ATTN: Document Service Center, Cameron Station, Alexandria, Virginia 22313

Request the following pen and ink changes be made to subject document:

a. Page 1. Telephone number of writer should read 2687.

b. Page 4, Paragraph 5. Correct parenthetical expression of third paragraph to read: (5 ounces to each 10 quarts of water).

c. Inclosure 5, Pages 1, 4, 5, and 8. Correct parenthetical expression at top of each page to read: (5 ounces to each 10 quarts water). Add note at bottom of each page as follows: April 1968 through February 1969, milliliters of 0.1 normal hydrochloric acid added to 10 milliliters of sample for pH 5.5.

FOR THE COMMANDER:

FLOYD E. WATTS
Technical Advisor

UNCLASSIFIED
Security Classification

DOCUMENT CONTROL DATA - R&D

(Security classification of title, body of abstract and indexing annotation must be entered when the overall report is classified)

1 ORIGINATING ACTIVITY (Corporate author) U.S. ARMY RESEARCH & DEVELOPMENT CENTER Coating & Chemical Laboratory Aberdeen Proving Ground, Maryland 21005	2a REPORT SECURITY CLASSIFICATION Unclassified 2b GROUP

3 REPORT TITLE
FIELD INVESTIGATION OF THE EXTENDED USE OF MILITARY ANTIFREEZE UNDER DESERT CONDITIONS

4 DESCRIPTIVE NOTES (Type of report and inclusive dates)
Final Report

5 AUTHOR(S) (Last name, first name, initial)
Jordan, Charles B.

6 REPORT DATE	7a TOTAL NO. OF PAGES	7b NO. OF REFS
July 1969	69	4

8a CONTRACT OR GRANT NO.	9a ORIGINATOR'S REPORT NUMBER(S)
AMCMS Code Nos. 4930.14.4969 and 2210.44 b. PROJECT NO. NA c. d.	C&CL #267 9b OTHER REPORT NO(S) (Any other numbers that may be assigned this report)

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	US Army Tank-Automotive Command Warren, Michigan 48090

13 ABSTRACT

The object of this test was to evaluate the use of antifreeze O-A-548a, Type I, under high temperature operating conditions and determine the possibility of extending the use of antifreeze beyond the specified one season.

Eight facility vehicles at Yuma Proving Ground were utilized during the test and operated under normal conditions. Four vehicles contained a 50% O-A-548a, Type I, antifreeze solution plus O-I-490a inhibitor. The remaining vehicles contained tap water plus O-I-490a inhibitor.

Results of this test verify results of previous tests which showed that dilution and proper antifreeze addition is difficult to control. Over extended periods a high volume of antifreeze replacement is necessary due to leaks, mechanical failure, evaporation, and overflow. In the field, uncontrolled, improper additions would lead to extensive and expensive cooling system damage. This test reaffirmed that it is not desirable to extend the use of antifreeze beyond the one season specified in TB 750-651.

Overheating was not experienced in any of the vehicles under the conditions of this test.

DD FORM 1 JUN 64 1473

UNCLASSIFIED
Security Classification

14. KEY WORDS	LINK A		LINK B		LINK C	
	ROLE	WT	ROLE	WT	ROLE	WT
Antifreeze Field Test O-A-548a, Type I O-I-490a Extended Use Overheating						

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